POWER

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Write Yourself to the Fore

ONE of the large industrial establishments has an official or department the function of which is to browse through the current literature of its subject in a search for talent.

Genius, interest, ingenuity, resourcefulness, straight thinking, facility of expression are as essential to the successful conduct of a great manufacturing concern as machinery and mechanical skill.

It is no small part of the work of the executive to keep up his organization; to surround himself with the best in brains and knowledge and ability.

The discovery of a man may be as important to the progress of an enterprise as the discovery of a process or the invention of a machine.

And the company that finds the best men and fits them into its personnel and develops their possibilities is bound to be the leader unless it is carrying a heavy handicap in other respects.

And so the company referred to has all the books and papers in its field, all the proceedings of related societies, all the reports of lectures and meetings and discussions examined to see who is saying things and what they are saying and how they are saying them.

And in this way they are brought into contact with men who are actively interested in at least contiguous lines and through their writings, the things that they say and the way that they say them, get a cue to their potentialities as possible units in the organization.

Many a man has written himself to the fore out of nonentity and obscure surroundings.

The best way to perfect and organize one's own knowledge of a thing is to tell it to others, and to tell it with the definiteness and precision of the written word requires self-questioning and analysis that often leads to a more profound insight into the subject on the part of the author himself.

Many a gem of useful knowledge is interred with the bones of its possessor. Many a man who has the know-how misses his chance because those who could use his knowledge do not know him.

Get out your pad and pencil and write yourself to the fore.

F. R. Low

Results of an Engineering Study of Paper Coating Factory's Power Plant

By J. G. BERGER*

AN OUTLINE of the method followed in the study of the power problems of a factory. Engines were overloaded to the point of poor economy. Purchased current was recommended for auxiliary power, which plan reduced the cost of power.

FREQUENTLY, the power plant of a factory is loaded to the point where the prime movers are inefficient and the management is face to face with the problems of obtaining more power and of cutting the existing costs of generation. It is often necessary for the engineer to take into account considerations

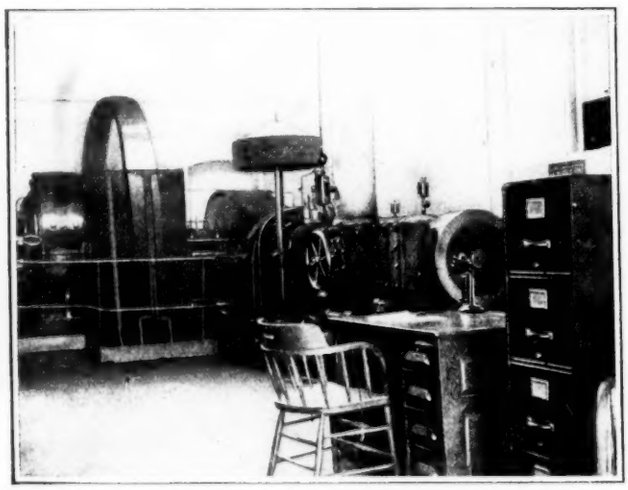

Fig. 1—The 20x42-in. engine carrying most of the load

other than the mere problem of what arrangement is the most economical.

The New Jersey Coated Paper Co., of Montclair, had seen its power requirements increase from year to year until in 1923 it was faced with the question of how to obtain greater economy in the power plant, for the large amounts of process steam and of power needed in the factory were major items in the production costs. In addition more power would be needed in the near future, as extensive factory extensions were planned.

Various machinery manufacturers volunteered much information as to the proper steps to be taken, each showing how his particular product would help solve the problem. While some efforts were commendable, the factory owners came to realize that, in view of the conflicting recommendations, an unbiased analysis of the plant situation was needed.

In order to avoid being influenced by any previous suggestion, all the data submitted by the machinery representatives were left unexamined. Instead a thorough study of the existing conditions was made by the author, who was engaged to make the analysis.

The power plant consisted of four 2,000-sq.ft. water-tube boilers. One of the boilers had an economizer

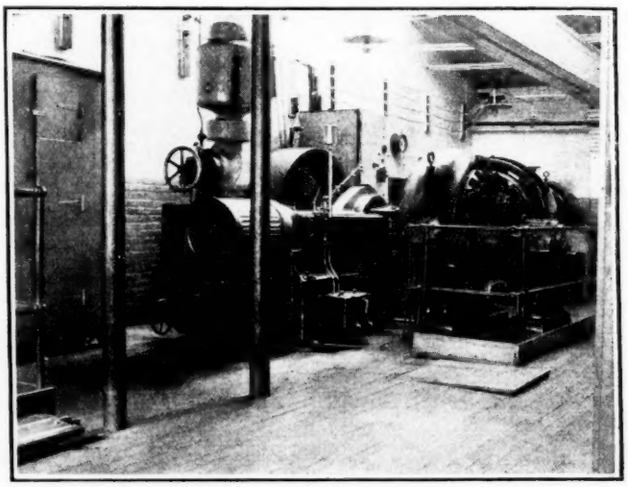

Fig. 2—The high-speed engine that was shut down, with the new motor-generator set in the background

and three were equipped with superheaters. One of these superheaters was later removed. The operating pressure was 140 lb. with 100 deg. of superheat at the boilers, although the steam upon reaching the engines had only 40 deg. of superheat. In the boiler room was the boiler-feed pump, which obtained its supply from the makeup tank by gravity. The condensate returns were pumped from the basement into the tank, where they mixed with the cold water makeup. Between the pump and boiler was a closed heater.

Generating Units

The generating units consisted of a Greenwald 20x42-in. engine direct connected to a 250-kw. 250-volt 100-r.p.m. direct-current generator in the main engine room. Here also was the switchboard.

In an adjoining room was a 14-in. bore by 15-in. stroke balanced-valve engine direct connected to a 100-kw. 250-r.p.m. generator. To supply the air used to lift the water from a deep well, a 10x10x8-in. steam-driven air compressor was installed in this room.

In the mill there were 80 motors totaling 854 hp., all using direct current at 230 volts, together with a

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battery-charging rheostat. A 6x10-in. slide-valve engine was used to operate the machine tools in the shop. To supply the air needed in the mill an 8-in. bore by 5½-in. stroke high-speed engine was direct connected to a blower.

Generally, exhaust steam was used for drying purposes and live steam for the preparation of the paper coating.

The data collected consisted of the tabulated items:

a—Coal burned during a working day.

b—Feed water used daily.

c—Condensate from all industrial processes.

d—Kilowatt-hours generated.

e—Live steam uses determined.

f—Various temperatures and pressures were recorded.

A thorough study was made of the time and manner of operation of all machinery in the mill in order to arrive at the diversity factor, load factor and maximum demand of the mill for both electric current and steam. Winter heating and dry-kiln steam were also taken into account.

Insufficient Power Causes Overtime

The studies revealed that this company had its existing generating equipment well loaded at times and could not operate the mill to the point of maximum production; in fact, calenders had to be run each night in order not to get behind the coating rooms. It was evident that more power was needed, and at the same time exhaust steam was blowing through the roof even after all that was required for industrial purposes had been consumed.

There were two ways to look at this situation—either install more efficient and larger generating equipment, which would furnish all the power needed and stop wasting exhaust steam; or, if first cost was an item, as later developed, additional power could be bought and the load on the existing equipment reduced

TABLE I—COMPARISON OF POWER PLANS

	Unaflow	Turbine		All Purchased Current
1. Investment necessary to make the change described in the report	$48,000.00	$65,000.00		$25,000.00
2. Yearly saving or loss thus obtained	7,542.00	7,842.00	Loss	420.00
3. Investment necessary using public service power for washing and charging	1,000.00	1,000.00		1,000.00
4. Yearly saving obtained by No. 3	1,617.00	1,617.00		1,617.00
5. Sum of items 2 and 4	9,159.00	9,459.00		1,197.00
6. Fixed charge, 11 per cent	6,370.00	8,580.00		3,380.00
7. Net yearly saving, item 5 minus 6	2,789.00	879.00	Loss	2,183.00
8. Total investment necessary, sum of items 1 and 3	49,000.00	66,000.00		26,000.00
9. Time it will take to pay for this investment out of savings, years	17.6	75	Loss	
10. Percent earned on the investment	5.7	1.33	Loss	
11. If the load were increased 50 per cent with no further investment in the power-plant equipment itself, the additional yearly savings by new method compared with present method employed	6,160.00	6,160.00		3,200.00
12. Total saving, items 7 plus 11	8,949.00	7,039.00		1,017.00
13. Time it would take to pay for the change if mill load were increased 50 per cent immediately, years	5.5	9.4		25.6
14. Per cent earned on the investment on this basis	18.25	10.6		3.9

to the point where the exhaust steam just met the factory demand for low-pressure process steam. Calculations proved that if a unaflow engine of 500-kw. capacity were installed, certain savings over the existing equipment would be obtained. Likewise complete use of purchased power would reduce costs.

In the unaflow plan existing boilers were to be retained, a 500-kw. unit installed, the two small engines, namely, in the machine shop and on one fan, together with the air compressor, would be motorized, but the brush washing and the battery charging were to be done with a small use of purchased power at night. A turbine of the same capacity was also considered as an alternate method, using the same arrangement as with the engine method.

Purchasing all the power meant the use of alternating-current motors in place of the small engines and a 250- and a 350-kw. motor generator set to supply direct current for the rest of the plant.

Several Plans Considered

Based on the tests made and careful calculations, the data in Table I were derived and were considered as accurate as obtainable in such an analysis.

As the existing equipment was still in good shape and would last for a number of years, about 200 kw. additional power over that obtainable from the large unit would suffice for some time to come, even allowing for a little future increase. It developed in going over this situation that by running the existing plant, adding a

TABLE II—OPERATING COSTS UNDER OLD AND NEW PLAN

	1922-23		1924-25
Tons of paper coated	7,248		6,993
Kilowatt-hours used:			
Greenwald	595,600	Public service	490,800
Small engine	186,500	Greenwald	452,300
		Skinner	64,700
	782,100		1,007,800
Mechanical power used	Machine shop and one fan		None
Repairs and supplies	$3,209.86		$2,783.84
Tons of coal	6,521		4,275.5
Cost of coal	$35,995.92		$19,325.26
Public service			$11,458.14

	1922	1924
Extra labor needed, one fireman	$1,855.00	
Coal in 1922 and 1923 cost 50c. per ton more; to place on same basis add 4,275.5 × 50c.		$2,137.75
Total cost	$41,060.78	$35,704.99
Cost per ton of paper handled	$5.64	$5.11
Saving per ton		$0.53
Assuming a 7,000-ton production, the yearly saving becomes 7,000 × 53c.		$3,710.00

200- to 250-kw. motor-generator set and driving the shop and fan load with alternating-current motors and likewise charging and brush washing with outside power with a small investment, the plant expansion could be made economically. This was based on the fact that 2,000 lb. of steam per hour that was lost through the roof as exhaust could be saved by reducing the load on the Greenwald engine and buying the balance of power. The logic of this is quite evident when restated as follows: Power was to be generated up to the point where the exhaust equaled the process demand and the additional power required was to be purchased.

Savings Made by Change

It was found that by investing about $10,000, this improvement could be made; after one year's operation under the new condition a comparison was made with the cost under the old arrangement for a year prior to July, 1923, whereas the operation with auxiliary power is a period of one year from March, 1924, the time at which the new method was put into effect.

Therefore in less than three years this improvement will be paid for, and the factory is equipped with additional power to take care of larger production when business conditions require it.

The situation is one by no means uncommon. Many factories do not find it advisable to increase capital investment by the amount required for a complete plant. Under such circumstances a judicious arrangement of purchased power and economical loading of existing machinery will prove to be extremely profitable.

The Theory of Cooling-Tower Operation

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THE determination of the characteristics of cooling towers has quite generally been accomplished by "rule of thumb" methods. Cooling-tower operation does, however, lend itself to rational analysis, and the object of this article is to present the relationships of the various factors governing such operation. The essential basic factors are—

1. The *dry-bulb temperature* is the temperature of the atmosphere as registered by an ordinary thermometer.

2. The *dew point* is the temperature at which the moisture present is a saturated vapor. If the atmosphere is cooled below this temperature, dew will form.

3. The *atmospheric vapor pressure* is the absolute pressure of the water vapor in the atmosphere, ordinarily expressed in inches of mercury. It is the pressure corresponding to the dew point as taken from the steam tables.

4. *Relative humidity* is the percentage ratio of the density of water vapor actually in the atmosphere to the density of water vapor that would exist in the atmosphere in a saturated condition at the observed dry-bulb temperature.

5. The *wet-bulb temperature* is the temperature a thermometer would register if its bulb were kept

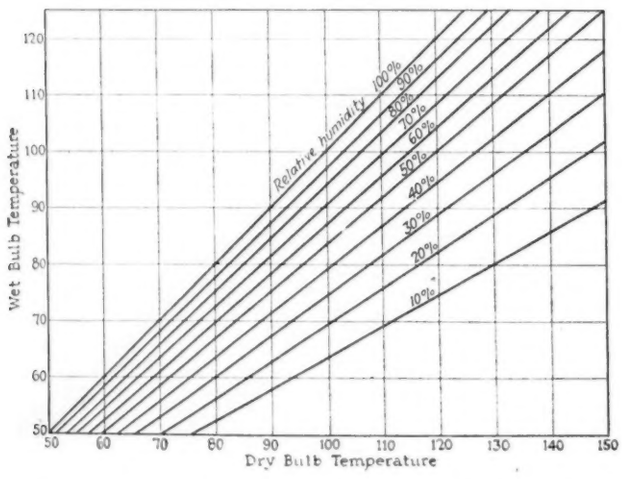


Fig. 1—Relative humidity determined from wet- and dry-bulb temperatures

moist and if it should be passed through the atmosphere at a velocity sufficient to provide for a rapid heat exchange. It is the temperature at which the rate of heat absorption by the bulb or the moisture upon it through conduction, as the result of the difference between the dry-bulb atmospheric temperature and the temperature of the wet thermometer bulb, is just equal to the rate of heat dissipation by the moisture of the bulb through evaporation, by reason of the difference between the vapor pressure of the moisture on the bulb and the atmospheric vapor pressure.

With atmospheric conditions corresponding to 70 deg. dry-bulb temperature with 60 per cent relative humid-

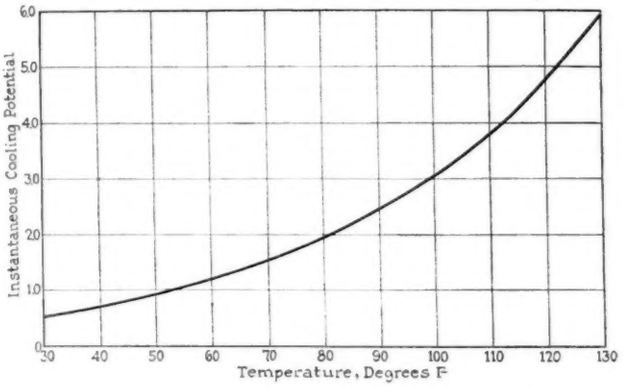


Fig. 2—Instantaneous cooling potential

ity, the weight of moisture contained in a cubic foot of atmosphere is 60 per cent of that which would be contained at 70 deg. if the atmosphere were just saturated with moisture.

Saturated water vapor at 70 deg. F. would have a density of 0.001148 lb. per cu.ft. (Marks and Davis' Steam Tables.) Atmosphere at 70 deg. F. with 60 per cent relative humiditiy would contain only 60 per cent of 0.001148, which equals 0.000689 lb. of water vapor per cubic foot. This is the density of water vapor at an absolute pressure of 0.44 in. of mercury, superheated to 70 deg. F. The temperature of saturation corresponding to 0.44 in. of mercury is 55.5 deg. This is the dew point and 0.44 in. of mercury is the atmospheric vapor pressure.

If the barometer should register 30 in. of mercury and a wet-bulb thermometer were whirled under these conditions, it would register 61 deg. F. Since the vapor pressure corresponding to 61 deg. saturation temperature is 0.541 in. of mercury absolute, this indicates that the heat given to the bulb by conduction from the air by reason of the temperature difference 70 — 61 deg. is equal to the heat dissipated by evaporation due to the difference between the vapor pressure of the water on the bulb and the atmospheric vapor pressure 0.541 — 0.44 in. of mercury.

A very interesting relation arises from this:

Let k = the rate of heat transmission by conduction expressed in B.t.u. per square foot of surface exposure between water and air per degree F. temperature difference per hour.

And E = the rate of heat transmission by evaporation expressed in B.t.u. per square foot of surface exposure between water and air per inch of mercury of vapor pressure difference per hour.

Then $k(70-61) = E(0.541-0.44)$, or

$$\frac{k}{E} = \frac{0.101}{9} = 0.0112 \qquad (1)$$

An examination of the Psychometric Tables issued by the United States Weather Bureau shows that this relation holds approximately throughout the whole table for a barometric pressure of 30 in. of mercury. An

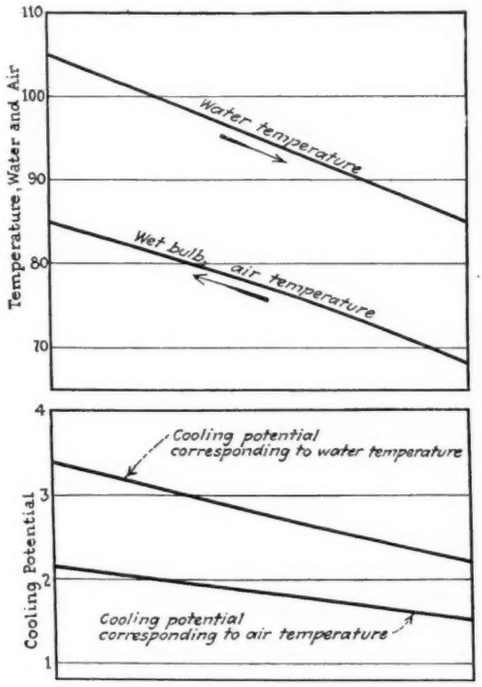


Fig. 3—Cooling potentials of air and water passing through a cooling tower vary with temperature

average of 150 readings taken at random from these tables gave a value of 0.0117 for this ratio. Coffey and Horne, in their paper before the American Society of Refrigerating Engineers, December, 1924, gave the ratio as 0.0116. This factor has the dimensional value inches of mercury per degree F.

This indicates therefore that the rate of heat transfer between air and water by conduction per degree F. per unit area bears to the rate of heat transfer by evaporation between water and air per inch of mercury per unit area a practically constant ratio equal to 0.0116.

It is to be understood that this ratio will hold whether the flow of heat by conduction is from the air to the water or from the water to the air if the temperatures of the surfaces of the air and water in direct contact are taken as the temperatures of these two media.

Ordinarily, agitation is such that the temperatures of the surfaces in contact at any element of the path may be considered as being the same as the corresponding average temperatures of the two media at this point.

This fact offers an easy point of attack for the analysis of water-cooling problems. Assume a drop of water at a given point in its fall through an atmosphere of air and water vapor. Let

t_1 = the temperature of a drop of water at any point in a cooling tower.

P_1 = the vapor pressure corresponding to temperature t_1.

t_2 = the dry-bulb temperature of the air in contact with the drop of water.

t_3 = the wet-bulb temperature of the air in contact with the drop of water.

P_3 = the vapor pressure corresponding to the wet-bulb temperature.

P_4 = the atmospheric vapor pressure, that is, the pressure corresponding to the dew point of the air in contact with the drop of water.

k and E be defined as above.

H = heat transmitted by conduction and evaporation expressed in B.t.u. per square foot per hour.

Assume the drop of water to have a surface of contact with the air of A square feet.

The heat lost by the water due to conduction per hour is

$$Ak(t_1 - t_2). \qquad (2)$$

The heat lost by the water due to evaporation per hour is

$$AE(P_1 - P_4). \qquad (3)$$

The heat lost by the drop per hour due to both causes is

$$AH = Ak(t_1 - t_2) + AE(P_1 - P_4). \qquad (4)$$

or

$$H = k(t_1 - t_2) + E(P_1 - P_4).$$

From the definition of the wet-bulb temperature the factor k times the difference between the air temperature and the wet-bulb temperature equals the factor E times the difference between the vapor pressure corresponding to the wet-bulb temperature and the vapor pressure corresponding to the dew point. That is,

$$k(t_2 - t_3) = E(P_3 - P_4), \text{ or} \qquad (5)$$

$$k(t_2 - t_3) - E(P_3 - P_4) = 0. \qquad (6)$$

Adding equations (4) and (6), there results

$$H = k(t_1 - t_3) + E(P_1 - P_3), \qquad (7)$$

or expressed verbally, this equation means that the

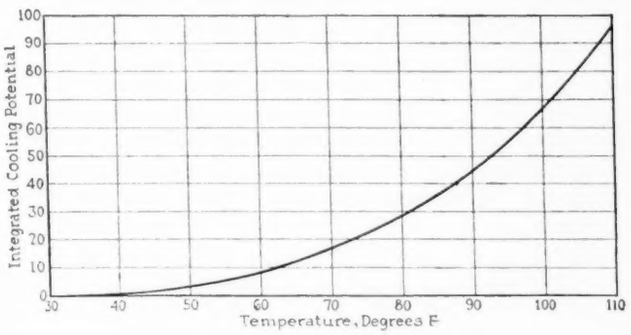


Fig. 4—Integrated cooling potential

amount of heat dissipated per hour by the drop of water equals some constant times the difference between the temperature of the water and the wet-bulb temperature of the air plus another constant times the difference between the vapor pressure corresponding to the temperature of the water and the vapor pressure corresponding to the wet-bulb temperature of the air.

Since the vapor pressure in either case is directly dependent upon a corresponding temperature, as given in the steam tables, it would be desirable to regroup the various terms of equation (7) as follows:

$$H = (kt_1 + EP_1) - (kt_3 + EP_3), \qquad (8)$$

which groups the temperature of the water and the

wet-bulb temperature with the respective vapor pressures.

If both sides of equation (8) be divided by the factor E, there results

$$\frac{H}{E} = \left(\frac{k}{E} t_1 + P_1\right) - \left(\frac{k}{E} t_2 + P_2\right) \quad (9)$$

But $\frac{k}{E} = 0.0116$ in. of mercury per deg. F.

Hence

$$\frac{H}{E} = (0.0116t_1 + P_1) - (0.0116t_2 + P_2) \quad (10)$$

Since H equals the amount of heat transferred per hour per unit of surface and E equals the amount of heat transferred per hour per unit of surface per inch of mercury, the value of $\frac{H}{E}$ represents the *difference in cooling potential* represented by the temperature t_1 and vapor pressure P_1 of the water and that represented by the temperature t_2 and vapor pressure P_2 corresponding to the wet-bulb temperature of the atmosphere. This is analogous to the *temperature difference* used in ordinary heat transmission problems, but is expressed in inches of mercury because the major portion of the heat transferred in cooling-tower operation is usually by evaporation, which is directly dependent upon vapor pressure difference.

Water at any given temperature will thus have a definite cooling potential above a base condition, as represented by the first parenthesis of the right side of equation (10), and air having any given wet-bulb temperature will have a definite cooling potential above the same base as represented by the second parenthesis.

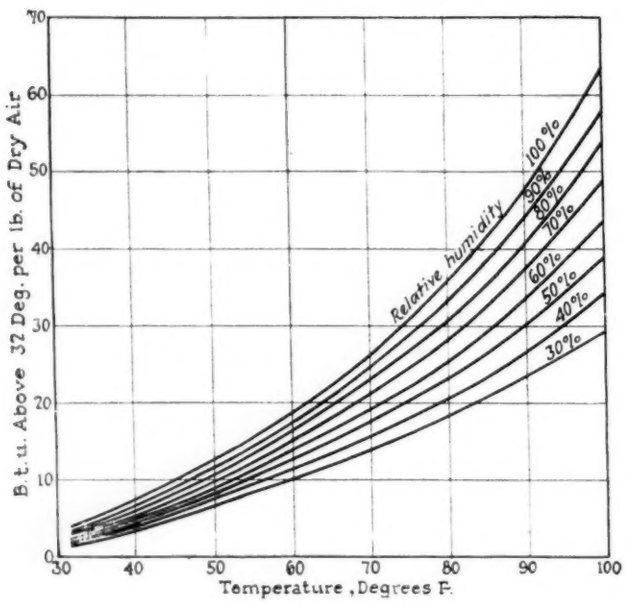


Fig. 5—Heat content of one pound of dry air plus that of the accompanying water vapor

The difference will represent the cooling potential difference tending to cause heat transfer.

For example, consider a drop of water at a temperature of 100 deg. F. surrounded by an atmosphere having a dry-bulb temperature of 75 deg. F. and a relative humidity of 70 per cent. The drop of water would have a vapor pressure of 1.926 in. of mercury. Its cooling potential would be $(0.0116 \times 100 + 1.926) = 3.086$ in. of mercury.

The atmosphere at 75 deg. dry-bulb temperature and 70 per cent relative humidity would have a wet-bulb temperature of 68 deg. F. (see Fig. 1), which would correspond to a vapor pressure of 0.690 in. of mercury.

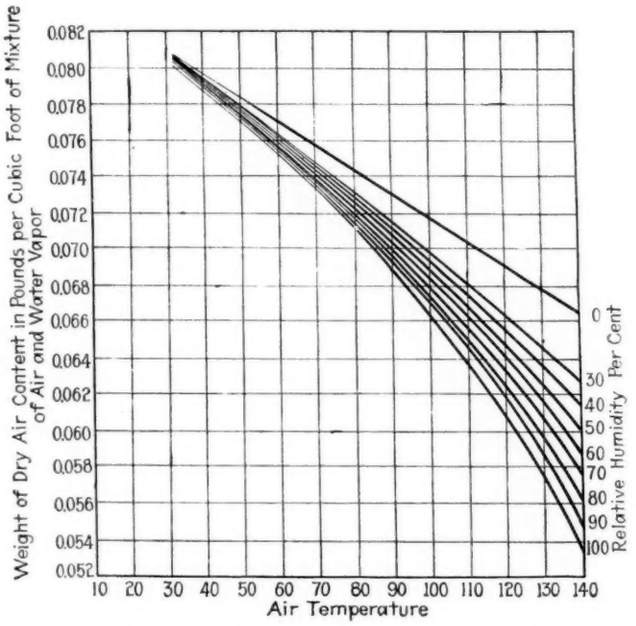


Fig. 6—Weight of dry air in one cubic foot of mixture of air and water vapor

The cooling potential of the atmosphere under these conditions would be $(0.0116 \times 68 + 0.690) = 1.479$ in. of mercury.

The cooling potential difference between the water and the atmosphere would be $3.086 - 1.479 = 1.607$ in. of mercury.

In the same way the cooling potentials for various temperatures of water and wet bulb have been calculated and the results are shown by Fig. 2. The cooling potentials corresponding to any ordinary water temperature and any atmospheric condition as represented by the wet-bulb temperature may be taken from this curve directly, and their difference will represent the *instantaneous value* of the cooling potential difference.

It must be emphasized that the value thus found is the instantaneous value of the cooling potential difference for the particular conditions set forth. In a cooling tower the temperature of the water and the temperature and the vapor content of the air are all changing continuously. For example, in a tower cooling water from 105 deg. to 85 deg. with the atmosphere entering the tower at 75 deg. with 70 per cent relative humidity (68 deg. wet-bulb temperature) and leaving with a wet-bulb temperature of 85 deg. (probably saturated with water vapor), the operating conditions throughout the tower would be as set forth in Fig. 3. There is quite a variation in the value of the cooling potential difference, its value being greater under the higher than under the lower temperature conditions.

In order to estimate the size of a cooling tower necessary to fulfill given cooling requirements, it is essential to know the mean value of the cooling potential difference. In order to determine this, reference is made

to Fig. 4. The curve of Fig. 4 is made up from the values of the instantaneous cooling potentials shown in Fig. 2. A temperature of 32 deg. is taken as the base, and the areas under the curve of Fig. 2 in "cooling potential degrees" between 32 deg. and the given temperatures are plotted as the ordinates corresponding to the given temperatures on Fig. 4. The result is that an ordinate in Fig. 4 represents the summation of the instantaneous cooling potentials between the given temperature and 32 deg. The difference between the ordinates corresponding to two given temperatures represents the summation of the instantaneous cooling potentials between those two temperatures, and the quotient obtained by dividing this value by the difference in temperatures represents the mean cooling potential. The difference between the mean cooling potentials for the water and for the air as found in this manner will be the *mean cooling potential difference.*

Thus for the conditions of operation of Fig. 3, that is, water being cooled from 105 deg. to 85 deg. while air is being heated from a wet-bulb temperature of 68 deg. to a wet-bulb temperature of 85 deg., Fig. 4 shows:

WATER

	Temperature, Deg.	Integrated Cooling Potential Above 32 Deg.
Inlet	105	81.0
Outlet	85	36.2
Difference	20	44.8

$$\text{Mean cooling potential} = \frac{44.8}{20} = 2.24 \text{ in. of mercury}$$

AIR

	Wet-bulb Temperature, Deg.	Integrated Cooling Potential Above 32 Deg.
Outlet	85	36.2
Inlet	68	14.85
Difference	17	21.35

$$\text{Mean cooling potential} = \frac{21.35}{17} = 1.254 \text{ in. of mercury.}$$

Mean cooling potential difference = 0.986 in. of mercury.

This method is valid only on the assumption that the rate of heat transfer for the cooling surface included within every cubic foot of cooling tower filling, per inch of mercury of mean cooling potential difference is constant throughout the tower for a given set of operating conditions. Experience seems to indicate that this is practically the case.

The Size of a Cooling Tower

In order to determine the size of a cooling tower to cool a stated amount of water through a given range of temperature with atmospheric conditions given, it is necessary to have determined by test what this rate of heat transfer is for the particular type of tower and conditions of operation. For various types of filling and rates of flow of water and air this rate of heat transfer may vary from as low as 750 to as high as 2,500 B.t.u. for the cooling surface included within a cubic foot of space occupied by the filling per inch of mercury mean potential difference per hour.

For the range of temperatures set forth in Fig. 3 let it be assumed that 2,000 gal. of water per minute are to be cooled from 105 deg. to 85 deg. with atmospheric conditions corresponding to 75 deg. dry-bulb temperature with 70 per cent relative humidity, and further let it be assumed that the conditions are such that the rate of heat transfer is 1,500 B.t.u. per cubic foot of space occupied by the filling per inch of mercury mean potential difference per hour.

B.t.u. per hour =

$$2{,}000 \times 8.33 \times 60 \times (105 - 85) = 20{,}000{,}000.$$

Mean cooling potential as given above = 0.986 in. of mercury.

Required space occupied by the filling =

$$\frac{20{,}000{,}000}{0.986 \times 1{,}500} = 13{,}530 \text{ cu.ft.}$$

Air Requirements

If the tower is to be of the forced-draft type, it is necessary to determine the quantity of air to be circulated. Fig. 5 shows in graphical form the heat content above 32 deg. F. per pound of dry air in mixtures of air and water vapor at an atmospheric pressure of 30 in. of mercury.

For the foregoing example with atmosphere entering the tower at 75 deg. with 70 per cent relative humidity and leaving at 85 deg. (assumed saturated) while absorbing 20,000,000 B.t.u. per hour, the amount of air necessary may be determined as follows from Fig. 5:

B.t.u. per pound of air at 85 deg., saturated, above 32 deg.	41.5
B.t.u. per pound of air at 75 deg., 70 per cent relative humidity, above 32 deg.	24.5
B.t.u. absorbed per pound of air	17.0

$$\text{Pounds of air required per hour} = \frac{20{,}000{,}000}{17.0} = 1{,}176{,}470$$

Or 19,608 lb. per minute.

Fig. 6 gives the weight of the dry-air content of a cubic foot of a mixture of air and water vapor at different relative humidities with a barometric pressure of 30 in. of mercury. For the particular example with 75 deg. air temperature and 70 per cent relative humidity the weight of the dry-air content per cubic foot of mixture is 0.0728 lb. The cubic feet of air to be delivered per minute by the fans would be accordingly, $\frac{19{,}608}{0.0728} = 269{,}340$.

Heat Content of Air and Vapor

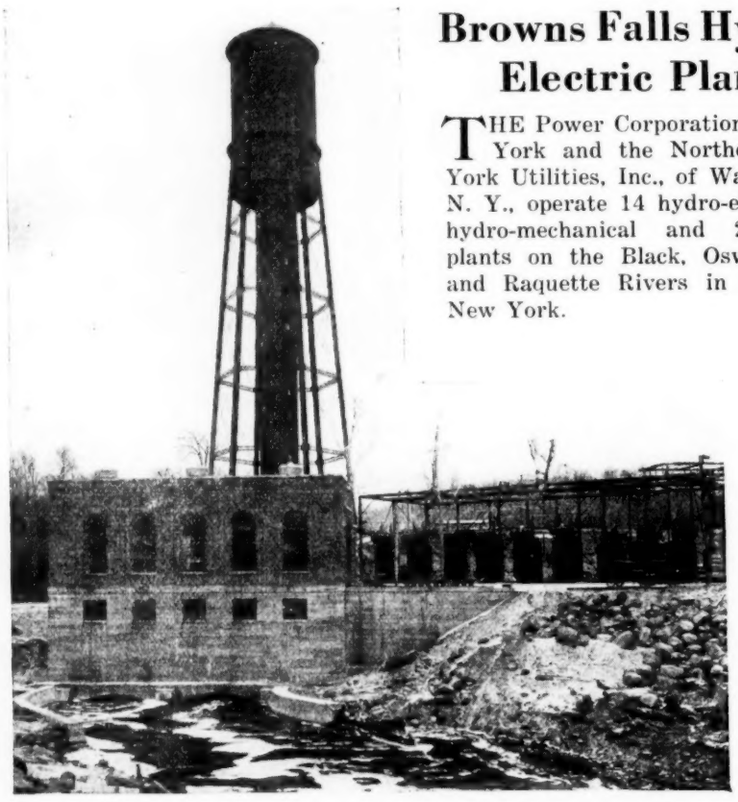
Particular attention is called to Fig. 5. It is to be noted that the heat content above 32 deg. per pound of dry air for any given conditions is the same as that shown on the 100 per cent relative humidity curve for the wet-bulb temperature corresponding to the given atmospheric conditions. All other curves on this figure except the 100 per cent relative-humidity curve may, therefore, be considered superfluous, provided the wet-bulb temperature corresponding to the given atmospheric conditions is used in connection with this 100 per cent relative humidity curve.

For this reason also, one is not particularly concerned to be certain that the atmosphere leaves the tower saturated as is ordinarily assumed, but not always definitely known, if the foregoing method of analysis of cooling-tower problems is followed. It has been shown that the wet-bulb temperature is the principal factor governing the effect of air conditions.

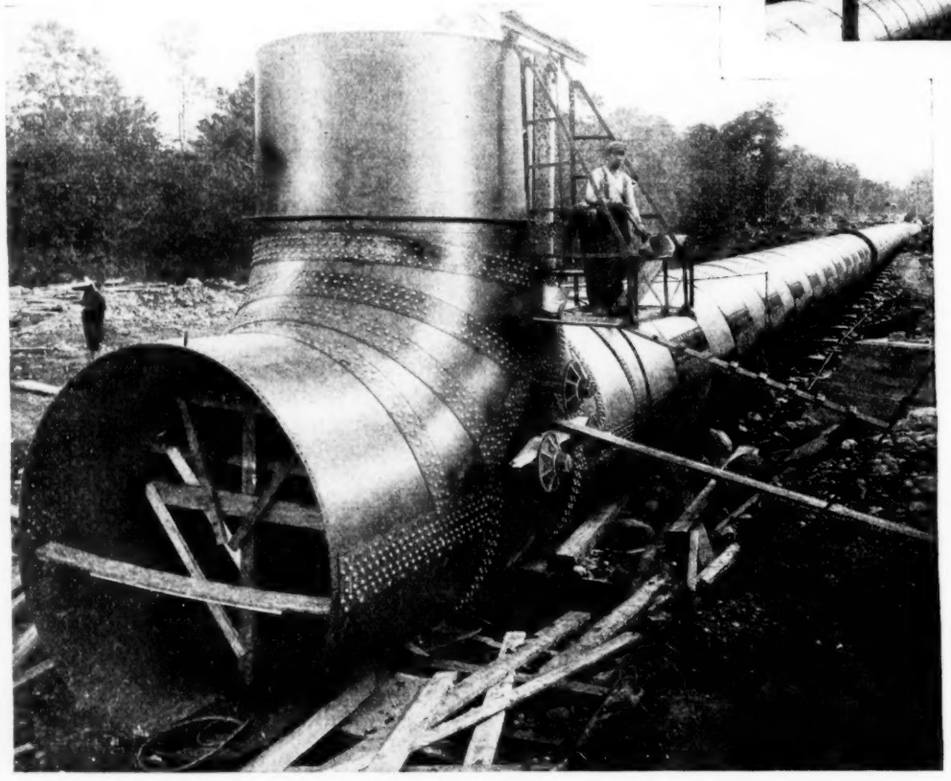
It is to be appreciated that this discussion is based on the assumption of a normal barometer of 30 in. of mercury. A variation of barometric pressure from this value will affect slightly the characteristics of cooling-tower operation, but such characteristics may be determined for different barometric pressures in the same manner as has been indicated.

Browns Falls Hydro-Electric Plant

THE Power Corporation of New York and the Northern New York Utilities, Inc., of Watertown, N. Y., operate 14 hydro-electric, 5 hydro-mechanical and 2 steam plants on the Black, Oswegatchie and Raquette Rivers in northern New York.

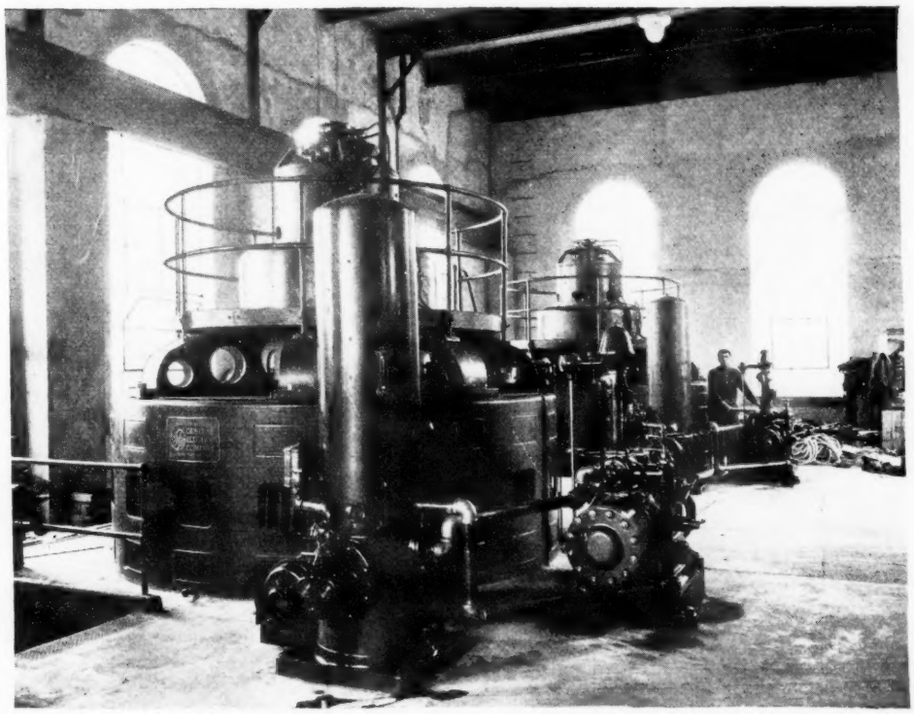


Above—Browns Falls plant, with a rating of 23,000 hp., is the largest on the system. The step-up outdoor transformer station is at the right of the plant



Above — Differential surge tank 193 ft. high and 40 ft. diameter located on the pipe line just above the power house. The surge tank and standpipe are lagged to prevent freezing.

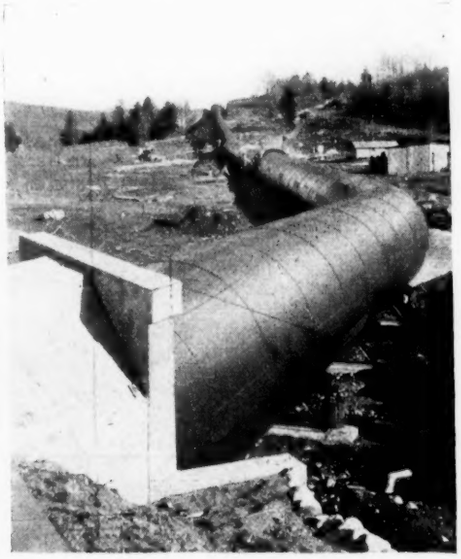
Left — Connection for surge tank to pipe line. The connection is cast into a concrete block and the three large staybolts reinforce the "T" connection.



Left — Two 11,500-hp. vertical-shaft units are installed. These operate under a net head of 260 ft., which is about twice as high as that used by any other plant on the system

Below — Junction of wood-stave and steel-pipe line at left. Pipe line is 6,850 ft. long, 3,800 ft. of which is wood-stave construction 12 ft. 6 in. in diameter, and the 3,050 ft. of steel pipe is 11 ft. in diameter

Below—Wood-stave pipe is supported in steel cradles resting on concrete foundations. These cradles extend nearly up to the horizontal diameter of the pipe



Right—Concrete dam at Browns Falls. This dam is 875 ft. long and 67 ft. high. From here the wood and steel pipe line extends nearly 1¼ miles to the surge tank just above the power house, from where two 8-ft. steel penstocks lead down to the turbines

Locating Faults in Electric Elevators—Direct-Current Controllers—II

Faults in the Controllers of Mechanically Controlled Elevators That May Cause the Motor to Start or Fail to Come Up to Speed if It Does Start

BY CHARLES A. ARMSTRONG

AFTER it has been ascertained that conditions in the power circuit are correct for operating the elevator motor and controller, as described in the article in the Nov. 3 issue, and the motor fails to start, then attention should be given to the other circuits. On elevators that are operated from a hand rope or a wheel in the car, the direction switches are usually of a mechanical form, such as a cylindrical type, Fig. 2, or a type closed and opened by cams on a shaft operated from the shipper wheel, shown on the right, Fig. 1; or any of numerous other devices that are employed. These switches, being of the mechanical type, are positive in their action and should close when the control mechanism is thrown to either the up or down direction.

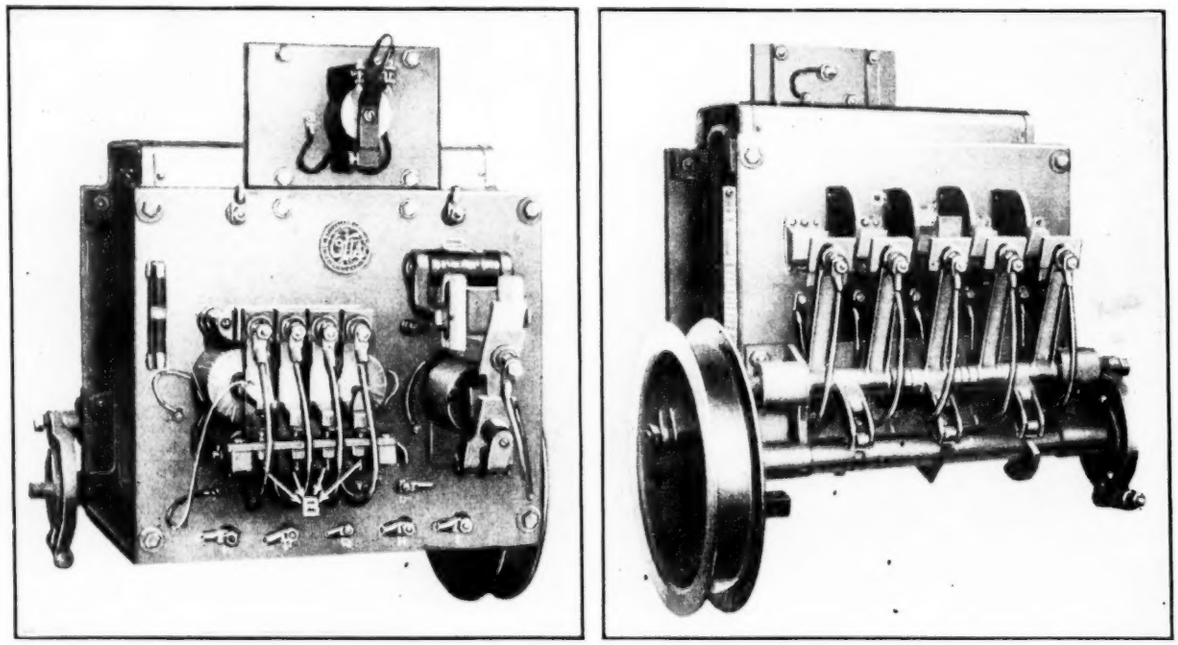


Fig. 1—Mechanical or semi-magnetic type controller for traction elevator

Assume that it has been found that the power circuit is complete and alive to the controller, and the motor fails to start when the reverse switch is closed. There are two conditions, one where the motor will not start with the switch closed for one direction and will start with the reverse switch closed for the other direction. Such a condition would indicate that the trouble was in the reverse switch, which, when closed, the motor failed to start. This confines the search for the trouble to a small part of the equipment. In such cases it will generally be found that the contacts on the switch have become worn or are out of adjustment and do not touch so as to make the circuit. It is also possible that the contacts have become broken or otherwise made inoperative, or their connections may be loose or broken.

To make an inspection of the reversing switch, open the line switch and pull the control to the position in which the motor failed to start. In this way it can be readily seen how the contacts fit and loose or broken connections can be looked for at the same time.

The second condition is that where the motor fails to start with the reverse switch thrown for either direction. It is possible for the reverse switch to be out of order for one direction, but not very likely for both directions at the same time. Therefore, if the motor fails to respond with the reverse switches in either direction, it is a pretty good indication that the cause of the trouble is somewhere else than in the switches. The first thing to observe is that the switches function properly, as this will show whether the fault is in the mechanical operating mechanism or in the electric circuits.

Assume that the direction switches have been found to function properly, then the source of the fault may be assumed to be in the motor-circuit wiring. To make

sure that the power circuit is complete to the controller, it is well to make a test across the first two line terminals in the controller. For example, in Fig. 3 the + side of the main line or potential switch *PC* is connected to 5 on the direction switches, and the — side is connected to *H* on the controller. If a lamp is connected from 5 to *H* and the potential switch closed, the lamp should light. Failure of the lamp to light

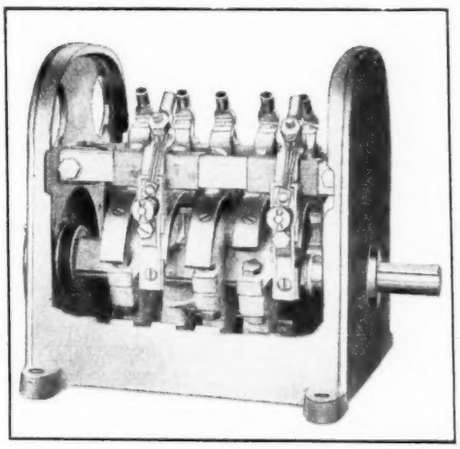


Fig. 2—Cylindrical-type reversing switch

would indicate that something was wrong in the power circuit before it actually reached the controller.

Where only one terminal can be found on the controller, one lamp lead can be connected to this and with the other test on the part of the controller to which the opposite side of the power circuit leads. For example, in Fig. 3 only terminal *H* is on the controller, 5 being on the reverse switches located on the end of the drum shaft as at *A* in Fig. 4. In this case one lead of the test lamp can be connected to *H* terminal on the controller and with the other lead test on the reverse switch located over the end of the drum shaft. If the circuit is complete, a light should be obtained. If the lamp does not light, this places the location of the fault somewhere between where the test was made and the power supply.

Where the test shows that the circuit is alive to the controller and the motor will not start with the reverse switch in either position, then the most likely place to find the fault is in the motor or starting resistance, although it is possible for the fault to be in any part of the armature circuit. The starting resistance and series field may be tested by connecting a lamp in series with the armature, then close the line switch and then the accelerating switch by hand. Closing the accelerating switch cuts out the starting resistance and series-field winding, therefore the lamp should light if the armature circuit is complete. In this way the source of the trouble will be segregated and can be easily located.

With a time-limit type of controller—that is, where the time of cutting out the starting resistance is controlled by a dash pot, as in Fig. 5—the starting resistance will be cut out of circuit whether the motor circuit is complete or not. With such a controller if the starting resistance or series-field winding opens, the accelerating switch will function to cut out the starting resistance, but the motor does not start. When the arm on the accelerating switch moves by the contacts to which the open section of the resistance is connected, the motor armature circuit will be completed. On account of part of the starting resistance or the series winding being cut out of circuit, the inrush current will probably be sufficient to blow the fuses and cause burning at the contacts where the open is in the motor-circuit, clearly indicating the source of the trouble.

On some machines with mechanical-type controls the motor circuit goes through an ultimate limit switch that is opened by the drum-shaft limits when the car goes by the terminal landings. These switches have been known to open accidentally, so that when the motor fails to start it should be ascertained if such a limit switch is part of the control equipment and if so, is it in the closed position?

The foregoing discussion is based on the premise that when the direction switches were closed, the motor did not start and when they were opened, no arc was obtained at the contacts. It is possible to have the motor fail to start and obtain a heavy arc at the switch contacts when they are opened. This would indicate that current was passing through the motor, but owing to some fault it could not start. This could be caused by the wormshaft jamming in the thrust bearings, the motor bearings worn to allow the armature to rub on the polepieces, or the motor bearings set on the armature shaft. These things have happened, but they are of rather rare occurrence.

Test for such faults would be to open the brake and see if the armature and wormshaft and other moving parts of the equipment move freely. If there is no load in the car, the armature and wormshaft should turn freely in the direction that will raise the car, as the counterweight is generally the heavier of the two.

A more likely cause of the motor not starting properly is a short-circuit in a group of coils in the armature. In this case the armature will generally start,

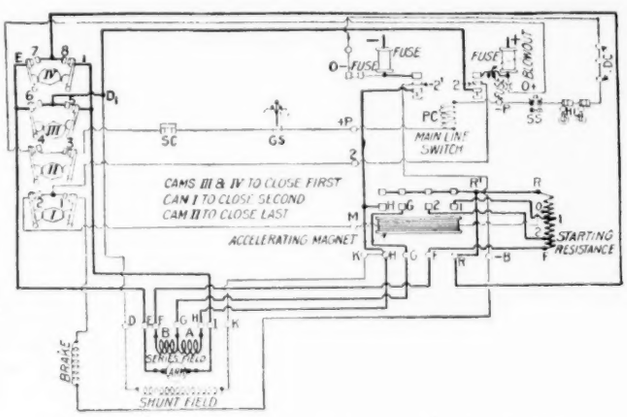


Fig. 3—Diagram of an Otis semi-magnetic type controller for drum-type elevators

but will not come up to full speed, but turn slowly and act as if heavily loaded. This will cause heating of the armature coils and the starting resistance and may blow the fuse if the controller is of a type that will cut out the starting resistance under overload conditions.

Another cause of the motor failing to start is the brushes shifted off the neutral, and their position should be checked.

Where power is supplied from a two-wire un

grounded system, if a ground occurred on the side of the line, going directly to the motor and also in the armature or series winding, the motor would not start and if part of the starting resistance is cut out the fuses would blow. If the ground is on the side of the line in which the starting resistance is connected, the fuse will blow as soon as the reversing switch is closed. On a three-wire system with a grounded neutral the fuse would blow whenever a ground occurred in the armature circuit of the motor, operating on the full voltage of the system, when the reverse switch is closed. Combinations of grounds in the motor and controller have been known to allow the elevator to operate in one direction and blow the fuses when the reverse switch was thrown to the other direction.

With an open in the shunt-field circuit, the motor will generally start if it is not too heavily loaded, but the fuses will blow if the starting resistance and series-field winding are cut out of circuit. Test can be made for an open in the shunt-field-coil circuit by opening the armature circuit and pulling the controller to the on position. For example, in Fig. 3 the armature leads can be disconnected at *I* or *E*. When doing this, precautions should be taken to prevent the loose lead-making contact with some other part of the motor and causing a short-circuit when the controller is pulled to the on position.

The brushes may be insulated from the commutator with a piece of cardboard instead of disconnecting the armature leads. When doing this, care must be exercised to see that carbon and copper dust on the brushes does not form a conducting path from the brushes to

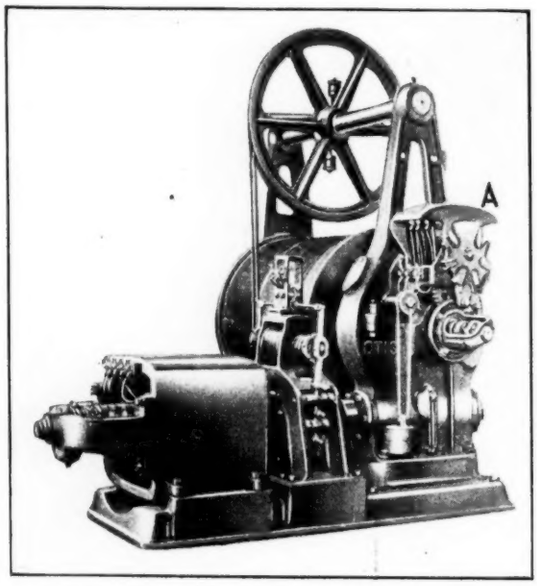


Fig. 4—Drum-type elevator machine

the commutator and cause an arc that will damage the commutator when the switch is closed. When the controller is put in the on position with the armature circuit open, if the field coils are energized the polepieces will attract a screwdriver or any piece of iron that may be brought near them. When the switch is opened, an arc should be obtained at its contacts.

Another cause that may prevent the motor from starting when the circuit is complete through it, is the brake not releasing. Where the brake is mechanically operated, it is not likely to fail to open. As the lining wears out of the brake shoes, adjustments are generally made to take up the increased clearance between the brake shoes and the pulley when the brake is released. When the old linings are replaced with new ones, the latter may be so thick that the operating

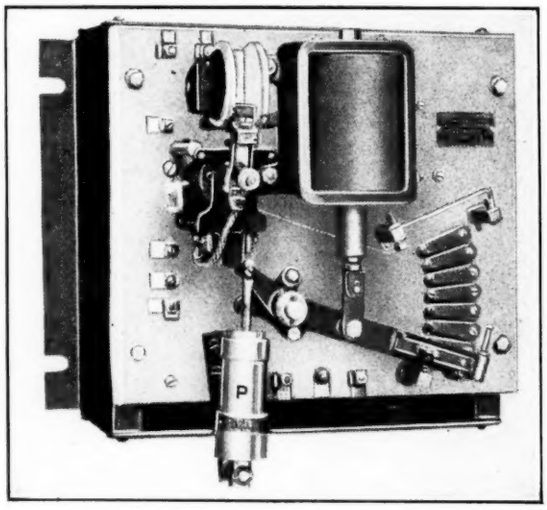


Fig. 5—Cutler-Hammer time-limit type controller

mechanism cannot lift the shoes far enough to release the brake until it has been adjusted for the new linings.

Where the brake is operated electrically, there are a number of causes for its failing to release. First, the coil circuit may be open, which can be due to broken wires in some part of the circuit, or the contacts that open and close the circuit may be out of adjustment, worn so that they do not close, or they may be prevented from closing by dirt between them. If the circuit is complete, the cores may be so far out of the coil that the latter will not develop sufficient pull to release the brake.

In one case the brake shoes were installed after they had been lined and no adjustment made so that the coil could lift the shoes. In this case the motor could operate the elevator when the brake was applied, with the result that the new brake linings were badly burned before it was discovered that the brake could not release.

On some brakes a resistance is connected in series with the brake coil and this resistance is short-circuited by contacts when the brake is applied. This allows the coil to be connected directly across the line to obtain a strong pull for releasing the brake. When the brake releases, the contacts short-circuiting the resistance open and cut the resistance in series with the brake coil. If these contacts get out of adjustment and do not close when the brake is applied, the resistance will remain in series with the coil and it cannot develop sufficient pull to lift the brake shoes.

On the other hand, if the resistance were open-circuited and the contacts closed, as they should when the brake is applied, this would cut the resistance out of circuit. When the brake coil is energized, it will start to release the brake, but when the resistance contacts part, the coil circuit will be opened and the

brake released and then immediately applied again. In some cases the arc at the contacts, when they open, may hold across and the brake remain released. In such event the contacts will soon be burned so short that they will not meet when the brake is applied, and the coil circuit will then be opened through the resistance, and the coil cannot be energized to release the brake.

On some types of controllers compound brake coils are used. A shunt coil is connected across the line, as in Fig. 3, and in addition a series coil is connected in the armature circuit. This series coil is cut out of circuit with the series winding on the motor, so that it is used only to assist the shunt coil in releasing the brake. It is necessary that the coils have the same polarity or the effect of one will neutralize that of the other and the brake will not release. Once connected properly, the coils will remain so unless someone changes the connections. On other types of brakes they are equipped with a dashpot to control the operation of the brake. Through neglect the dashpot may get into such condition as to stick and prevent the coil from releasing the brake.

Failure of the accelerating switch to function and cut out the resistance will depend largely upon the principle on which this switch operated and how it is connected in the circuit. In any case an open-circuit through its coil or coils will prevent operation. This open-circuit may be due to an open in the wiring or loose connections, or the auxiliary contact that closes the coil circuit may be out of adjustment or making poor connection.

In the controller, Fig. 6, when the main-line switch M closes it completes the circuit for the accelerating-switch coil AC. The circuit is from the + side of the line through contact X, coil AC, resistance AB to the — side of the line. Resistance AB is short-circuited by a contact A'. If this resistance were open-circuited, it would not interfere with the coil raising the arm and cutting out the resistance until it reached near the end of its travel, when contact A' will open and in doing so open the coil circuit through resistance AB. In doing this, the coil releases the arm, which starts to drop down, allows contact A' to close and energizes coil AC, which will raise the arm again, open contact A' and the coil circuit. From this it will be seen that the arm oscillating up and down at the upper end of travel would indicate that the resistance, in series with the coil, is open-circuited. If contact A' did not short-circuit resistance AB, coil AC could not develop sufficient pull to raise the arm and cut out the starting resistance.

The coil circuit of main-line switch M is from the + side of the line to L through the slack-cable and limit switches back to C, through coil M, resistance H, starting-resistance arm and to the — side of the line. When coil AC raises its arm off the first contact, resistance D is cut into circuit with coil M. If resistance D is open-circuited, coil M will be de-energized and allow its switch to open and cut the power out of the motor The starting-resistance arm will drop to the off position and short-circuit resistance D out of circuit and again complete the circuit for coil M. This will start the motor again, only to have it stopped when the starting-resistance arm moves off the first contact. Where a switch has an oscillating movement, it is a pretty good indication that the resistance, connected in series with the switch, is open.

Where a dashpot is used to control the motion of a switch, unless given attention it is likely to give trouble, especially some of the earlier designs of dash pots. If subjected to extreme cold, dashpots are likely to be sluggish and stick, and at high temperatures they may operate too freely unless properly adjusted.

In some cases the starting-resistance arm has been known to stick in the up position and cause the fuse to blow when the direction switch is closed. Where the line contactor coil M is connected as in Fig. 6, the starting-resistance arm must return to the off position or the line switch will not close, on account of resistance D being connected in series with coil M.

On the controller, Fig. 3, the accelerating switch operates on the counter-electromotive-force principle. In this case the motor must start and build up a certain voltage across its terminal before sufficient current

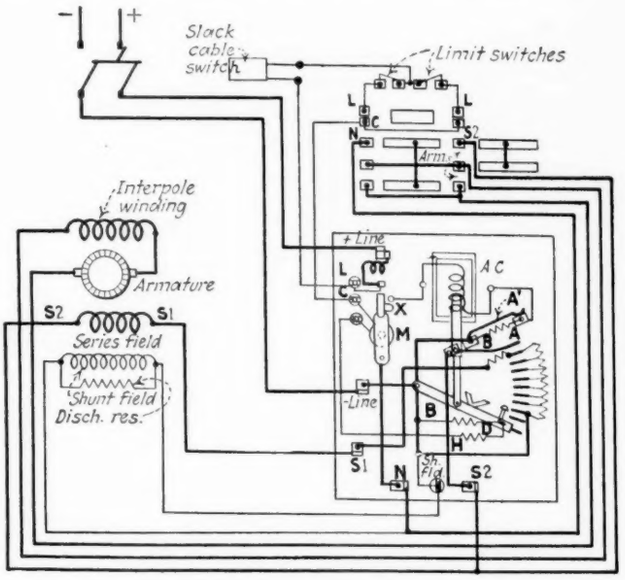


Fig. 6—Diagram of the controller Fig. 5

will flow in the coil to cause contactors 1, 2, G and H to close and short-circuit the starting resistance. If the motor is too heavily loaded, it may not be able to reach a speed where the contactors will close. Adjustments are made by screws B, Fig. 1, and when raised or lowered, the arms come closer or farther away from the magnet core. Adjustment can also be made by shifting point O, Fig. 3, where the coil connects into the starting resistance. Moving connection O toward F tends to make the contactors close at a lower speed on the motor and a given load, whereas moving O toward R has the opposite effect. When the elevator is installed, the proper location of O is made by the manufacturer and the only subsequent adjustment that may have to be made is of the contactors.

Methods of adjusting the accelerating switches vary with the type and make. If they are adjusted to accelerate the motor too quickly, it may result in blowing the fuse or impart an unpleasant motion to the car when starting. Mechanical types of controllers, such as discussed in this article, are comparatively simple and easy to locate trouble on. In fact, in many cases the cause of the trouble is evident from the effects. With the full magnet controller the detection of trouble may be somewhat more complicated and will be discussed in the next article to follow.

Further Reminiscences of George H. Reynolds

By W. H. ODELL

Mr. Odell, the author of these reminiscences, was a friend and co-worker of many of the old mechanical engineers who did things of note in the early days of engineering in America, when trial and error was the accepted rule, which gave occasion for many entertaining episodes that Mr. Odell humorously relates. "Power" has published several of these reminiscences, which may be found in Vols. 57 and 58, in the June 19, 26, July 3, 10, 17, 24 and Aug. 7, numbers of 1923.

MY FIRST meeting with George H. Reynolds, to whom I have referred in a former article, was a very stormy one. At the time, he was consulting engineer to the De Lamater Iron Works at the foot of Thirteenth St., North River, New York, while I had been known around the same works for about two months as the "steam sharp," but we had never met.

A 26x60-in. Rider cutoff engine and a 6x18-ft. horizontal return-tubular boiler had been sold to a silex works at Mystic Bridge, Conn. This engine had been guaranteed to run from 7 o'clock a.m. Mondays to 6 o'clock p.m. the following Saturdays without stop. Unfortunately, it developed a propensity to heat in the main journals, and every few days the brasses were sent back to the shop to be rebabbitted. On one of these trips James Miller, superintendent of the shop, or works, called my attention to them and asked what I thought was the trouble. I replied that, "so many miles away my guess was no better than any other person's," therefore I did not care to be quoted.

Mr. Odell Takes a Hand

Immediately, Mr. De Lamater sent for me and told me to go back with the brasses, take charge, and if possible find the cause of the trouble and in any event to stay with the engine until the guarantee had been filled, if it took all winter and to bring back the check in payment on my return. This I did, but as soon as I reached the silex works I began to see things, and my first move was to bore a half-inch hole through each cap and brass so that I could use grease if wanted. This cured that trouble.

I also saw that the workmen had established a thoroughfare through the engine room from one part of the mill to another part. They would enter the engine room through the snow and deposit the silex of their boots on the engine-room floor. This would soon dry and raise as a dust and settle on the guides, cutting them down an eighth of an inch in a week's run, I was told. No one seemed to have thought of that, but I stopped that thoroughfare, scrubbed the floor and that was the end of that trouble also.

One very cold morning a gentleman came in so bundled up in furs that all I could see of him was a little red mustache, the end of a very red nose and a pair of very bright eyes. This was Mr. Reynolds, but I did not know it as he made no attempt to make himself known. After shedding a lot of his furs, he asked to be shown a pair of indicator cards. As soon as he saw them, his eyes brightened and he said, "My, but that is a fine distribution of steam."

This greatly pleased me and I was inclined to forgive his gruff manner, and replied, "Yes, since I put an eighth inch 'dutchman' on the end of the valve rod, I have a very perfect distribution of steam." Right there his safety valve lifted, and he wanted to know "who in —— told me to put a 'dutchman' on the end of the valve rod?" With more heat than necessary, possibly, I replied that no one in —— or outside the gates needed to tell me to do a thing that I saw needed to be done, etc.

After we had both cooled down a little, he asked if I had any more trouble with the journals. I replied not since I had bored those half-inch holes through the caps and brasses.

Reynolds Indulges in Strong Language

Right there the lid blew off, and a finer string of brilliantly polished "cuss words" I never heard an educated man use. As a boy I had driven a team of mules on the farm and had become very proficient in the only language mules are amenable to, and I shot back with this mule language which I think must have disgusted him for he started for the door and in passing out he gave me his name and assured me he would report me to Mr. De Lamater. This he did but only in a most commendable way, assuring Mr. De Lamater he need have no worry about my putting through any job he put me in charge of, or knowing the reason why.

A short time after this, at Mr. Reynolds' suggestion I was engaged to do the indicating at the noted trial of the pumping engine at the Hope station of the Providence, R. I., water works, which brought me for the first time in touch with George H. Corliss and his staff of experts, as referred to in a former article in Power. I am most happy to take off my hat to George H. Reynolds, as a worth-while friend who had a most varied mechanical experience including about every form of machinery, from caloric engines to dynamite guns. During the memorial to Capt. John Ericsson some months since, an article, in fact several of them, appeared in the daily papers in which it was claimed it was in a great measure due to Mr. Reynolds' sacrifice that the "Monitor" revolutionized naval warfare, and possibly it may be permissible to introduce this correspondence in the hope some reader of *Power* may be able to throw more light on this interesting question.

The letters published in *The New York Times* referred to by Mr. Odell are in part as follows:

The Times yesterday had an interesting article on the anniversary commemoration of Capt. John Ericsson. Now, there is no doubt that Ericsson deserves all the credit for having built the "Monitor," but the credit for having produced the "Monitor" at the psychological moment in Hampton Roads is not to be credited to the Captain, but rather to my old friend and partner, George Reynolds, of Connecticut, the greatest mechanical engineer America ever produced, the head of the Delamater Iron Works during the period of its great prosperity fifty years ago; a man whose inventions recorded a distinct step forward in engineering.

In the 50's George Reynolds invented an engine that was a great improvement over anything that then existed. One of these engines was placed in a famous Sound steamer, which thereupon ran away from its nearest rival and for a long time caused the boat in which it was placed to remain the champion speedster of our great inland waterway.

While Ericsson was rushing work on the "Monitor," he was also trying to complete an engine of his own device. The government was pushing him to the extent of the speed limit in getting the "Monitor" under steam. He finished the boat in time, but not the engine. His friend Reynolds had one of his own engines at the Delamater works and finally induced Ericsson to permit the "Monitor" to be equipped with it. This was done, and the "Monitor" proceeded on her way to victory. . . . Signed "J. A. S."

Mr. Odell writes in reply:

May I express my heartfelt gratitude to your correspondent, "J. A. S.," for his tribute to the memory of George H. Reynolds?

I did not get acquainted with Mr. Reynolds until several years after the "Yankee cheesebox on a raft" had revolutionized naval warfare, and our first meeting was at a time when Mr. Reynolds was consulting engineer to the De Lamater Iron Works, then located at the foot of West Thirteenth Street, New York, and the writer had been employed by the said works some six weeks as a "steam sharp," as the men dubbed me.

Mr. Reynolds thought I had exceeded my authority—in other words, had "stolen his thunder"; while I thought I was the man on horseback and wanted everyone to keep out of my way or risk being run over. But since that first meeting and up to the time of Mr. De Lamater's death and the devolution of the works, we were the best of friends and were often employed as experts on the same job. But in all those years as "pals" I never knew the engine that was placed in the "Monitor" was of Mr. Reynolds' design until I read the article of "J. A. S." in *The New York Times*.

Now, the gist of all this is that, while I saw the "Monitor" in the building; saw her from the window of the shop in which I was serving my apprenticeship at the machinist's trade go down the East River on her way to that battle in Hampton Harbor; was intimately acquainted with Ericsson, De Lamater, Reynolds and many of the pioneer engineers of that day, and yet never learned the facts as presented in your issue of the 6th, is it not about time for the proposed "Museum of Engineering and Industry" to commence gathering these facts which are of so absorbing interest to every red-blooded American and safeguard them for coming generations? . . . W. H. ODELL.

Oil-Engine Design Tendencies

High-speed oil-engine developments are already causing some rivalry in the matters of light weight and high speed.

In comparing engines of a fixed bore-to-stroke ratio, operating at a constant speed but having different cylinder displacements, the total weights seldom vary directly, but rather as the square root of the horsepowers. For instance, if someone has succeeded in building an engine of 50 hp. per cylinder at 60 lb. per hp., an engine of 25 hp. per cylinder would weigh 84 pounds per horsepower. A series of engines is sometimes designed for which all bore and stroke ratios are constant, the piston speed is constant, and the speed is accordingly increased from the largest to the smallest sizes. All engines in this series may have the same weight per brake horsepower.

In keeping a constant piston speed from 25 to 100 hp. in a series, for example, the piston speed is gained by an increase of rotative speed, but inertia forces go up as the square of the speed. This makes it necessary to accept higher inertia forces or less satisfactory balance in the smaller engines where it is most necessary, except where reciprocating parts are lightened by special design. Automotive pistons and aviation pistons are never good examples for industrial work, so limits are soon reached.

The number of cylinders contributes much to a weight reduction. In one case when the single-cylinder engine weight per brake horsepower is taken as unity, the four-cylinder has a relative weight per brake horsepower of 0.5 and the 8-cylinder engine, of 0.44.

In comparing gasoline-engine weights with oil-engine weights, it must be considered that all tension and compression members are carrying 50 per cent more pressure normally in the case of the oil engine, and starting loads may cause them to carry double gasoline-engine pressures. There is no logical basis for assuming that this excess pressure can be ignored, except the view that gasoline engine builders have wasted metal. Economy in engine design is nothing new, and many think more engines have been overstressed than understressed.

The only objects, in the case of power plant or industrial units, of reducing engine weight is to reduce manufacturing costs and size. Any refinement that reduces weight while increasing the cost may be commercial for aviation or transportation equipment, but is not always good engineering in designing for stationary use.

To build an ultra-light-weight engine, aluminum is required. Cast iron is entirely ruled out of engines in this class. Aluminum castings are worth about 55c. a pound. They weigh one-third as much as iron castings if the sections are the same. If the average casting price over a whole engine is 6½c., then aluminum is interesting as an economical material when one can buy aluminum castings at 19½c. per pound.

Connecting rods, valve gears, etc., on all light-weight engines are drop forgings of alloy steel. It is not possible to drop forge a connecting rod as thin as it might be with very high-grade materials, and as thin as it should be for very high-speed engines. The rods are therefore machined all over. At the speeds required for industrial work, such a measure would be sheer extravagance, although it would slightly reduce the weight of the engine.

With reference to the amount of risk a designer should run in stress allowances, $5 worth of cast iron or even $100 worth of cast iron is far cheaper any day than the sacrifice of good-will, the lost sales, the express charges, replacements and service charges due to frequent wrecks. There are in force today two schools of designers. In aviation and such work men confessedly calculate the work to very close margins. In fact, they may calculate very little. The engines are subjected then to a breakdown test and a process of paring and reinforcement goes on until the equivalent of the one-horse shay is reached as nearly as possible. In a case of heavy-duty engines a process of this sort would continue for a period of ten to twenty years, by which time the engine would be out of date. The school of designers working on heavy engines depend very largely on calculation and records of past experiences.

The Use of Zeolites To Soften Water by Filtration

Kinds of Zeolites—Amount Required—Filtration Rates—Charts Simplify Calculations

By H. W. TERRY

WHILE "zeolites" have been known for many years, the growth of a large commercial demand has occurred mainly in the last ten years. For the benefit of those readers who have not followed this development in water softening it may be explained that zeolites are hydrated double silicates that have the power to take up the hardening or scale-forming bases from water, giving up their equivalents in sodium. For example, if a water containing calcium bicarbonate is filtered through a zeolite, it will contain sodium bicarbonate in place of the calcium bicarbonate, while the zeolite will hold the calcium taken from the water.

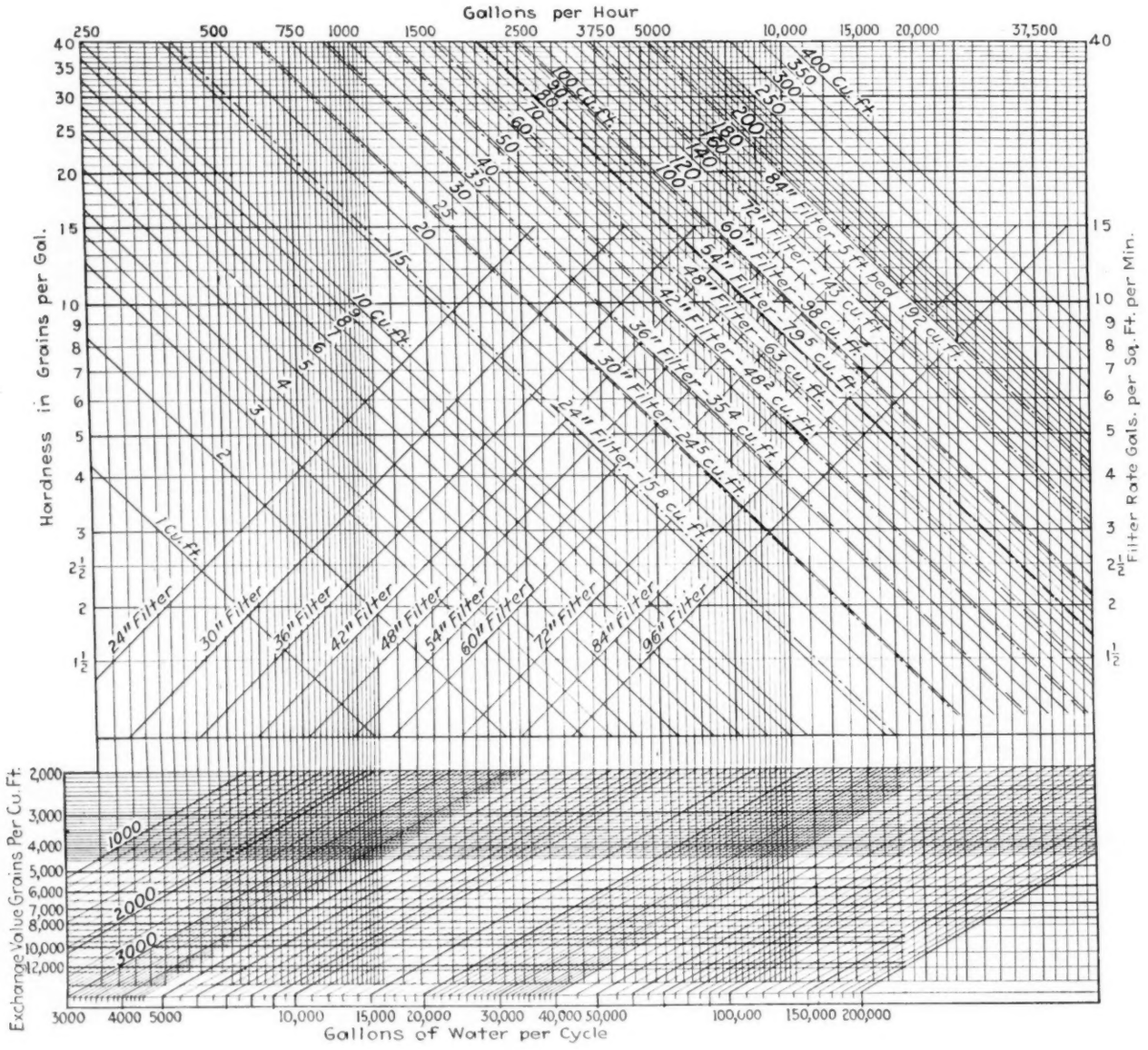


Fig. 1—Chart for finding cubic feet of zeolite and diameter of filters

As might be expected the zeolite will not continue indefinitely to function in this way, and when it has

become so charged with hardening bases that the water passing through it is no longer completely softened, it must be relieved of these bases. This is done by passing a brine solution through the zeolite, which causes a reverse reaction to take place, the zeolite taking up sodium and giving off the hardening bases.

The machine or filter containing zeolites may operate to pass the water either upwardly through the filter medium or downwardly, according to its design. Either method is successful, as the softening is caused by contact of the water with the zeolite.

The "Consolidated Freight Classification Guide" gives three classifications for use in shipping zeolites, namely: Sand processed for water softening; clay processed for water softening; water purifying compound.

"Sand processed for water softening," is technically known, before treatment, as glauconite and familiarly as green sand or Jersey marl. For many years Jersey marl was used to some extent as a fertilizer. During the war some money was spent upon a project for mining this sand and recovering the potash from it. This marl, however, finds its best-paying market as a filter medium for softening water.

"Clay processed for water softening" refers to a product mined and processed in South Dakota.

The classification "water purifying compound" includes filter media for water softening made by precipitation of zeolites from chemical solutions as well as zeolites made by fusing together the necessary ingredients.

The physical characteristics of these various materials as well as their chemical behavior determine the proper design of the filtering machine in which zeolites may be used.

Table I gives an estimate of the weight, size and exchange value of typical examples of the three classes of zeolites.

The exchange values given can be obtained when regeneration is completed in 30 minutes and one-half pound salt is used per 1,000 grains of hardness removed by regeneration.

The physical characteristics of these zeolites determine the filter rate that can be used; that is, the gallons of water that can be passed through the filter per square foot of filter area per minute. The filter rate determines the area or diameter of the filter.

A fine material hinders the flow of water downward through a filter and necessitates the use of low filter rates. On the other hand, if the flow is upward, a fine material will be carried upward with the water unless the filter rate is controlled.

Therefore, filters containing green sand operate at filter rates that do not greatly exceed the rates used in common-sand filters.

A light zeolite will pack if high rates are used and the flow is downward. If the flow is upward, a high rate will lift the material and carry it along with the water. In practice filters containing water-purifying compound operate at about the same rates as those using green sand.

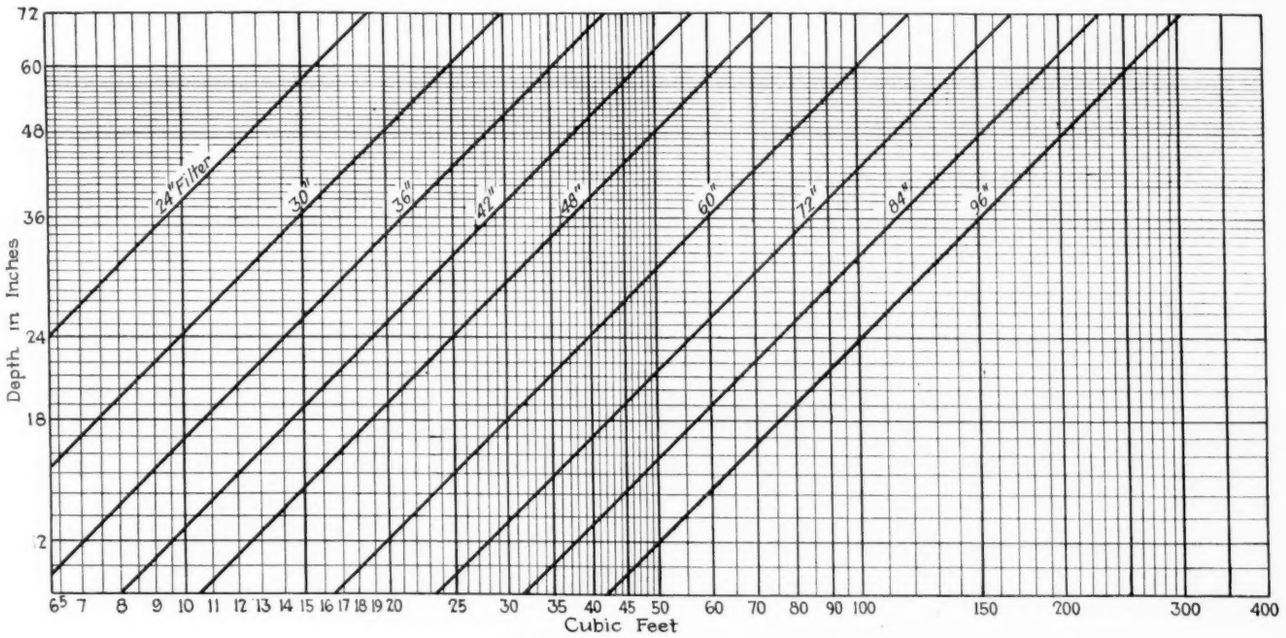


Fig. 2—Chart for finding depth of zeolite

Filters containing "clay processed for water softening" operate at much higher rates than those using other zeolites because the effective size of the grain is greater than that of either of the other zeolites and the weight is sufficient to hold the bed in place.

The following table gives filter rates ordinarily used in standard practice with commercial zeolites taken as examples of the three classes:

	Filter Rate, Gal. per Sq.Ft. per Min
Green Sand	
Downward flow	3 to 5
Upward flow	4 to 6
Water-Purifying Compound	
Downward flow	3 to 5
Upward flow	4 to 6
Clay Processed	
Downward or upward flow	10 to 15

To determine the filter diameter for any given filter rate the following formula is used:

$$\frac{Gal.\ per\ hour}{60 \times filter\ rate} = 0.785d^2$$

where d is the diameter in feet and the filter rate is in gallons per square foot per minute.

The total quantity of water to be softened during

one cycle or between regenerations determines the quantity of zeolite the filter must hold. That is, the total grains of hardness to be removed by the filter and the exchange value of the zeolite together determine how much zeolite must be used; naturally, the higher the exchange value of the zeolite the smaller the quantity required. The formula for determining the quantity of zeolite required to fulfill a given condition is as follows:

$$Cu.ft.\ of\ zeolite = \frac{\left(\begin{matrix}hardness\ in\ gr.\\ per\ gal.\end{matrix}\right) \times \left(\begin{matrix}gal.\ of\ water\\ to\ be\ softened\ per\ cycle\end{matrix}\right)}{exchange\ value\ of\ zeolite\ in\ gr.\ per\ cu.ft.}$$

The exchange value per cubic foot is ordinarily considered to be constant for hardness between 1 and 20 grains and to be 10 per cent lower between 20 and 40 grains. The experiments of the author, however, lead him to the conclusion that the reduction in exchange value per cubic foot is greater between 1 and 10 grains than it is between 10 and 40 grains.

TABLE I—APPROXIMATE CHARACTERISTICS OF ZEOLITES
(Freight Classification)

	Weight per Cu.Ft., Lb. Air Dried	Weight per Cu.Ft., Lb. Wet	Exchange Value in Grains per Cu. Ft.	Size
Water purifying compound	25	50	8,000	30-mesh
Green sand	85	100	2,800	60-mesh
Clay processed	50	70	4,400	20-mesh

Charts to Facilitate Calculations

To make these points clear in a practical way, two charts have been prepared. Fig. 1 is constructed to give the filter diameter and the cubic feet of zeolite to fulfill any condition within the range of the chart, being given the gallons of water to be softened per cycle, the hardness of the water and the filter rate.

Fig. 2 can be used to determine the depth of a zeolite bed in a filter, being given the cubic feet of zeolite it is to contain and the diameter of the filter.

Suppose that it is required to soften 5,000 gal. per hour and 20,000 gal. between regenerations, water 5 grains hard, filter rate not to exceed 10 gal. per sq.ft. per min., exchange value 4,400 gr. per cubic foot.

On the lowest scale of Fig. 1 locate the point marked 20,000 gal., follow the diagonal line through this point to its intersection with the horizontal line representing an exchange value of 4,400. Follow the vertical line through this point to its intersection with the horizontal line representing 5 grains (see figures on the left-hand side of the chart).

This point of intersection falls between the left sloping lines 20 and 25 representing cubic feet. By inspection the intersection is determined to represent 23½ cu.ft. The chart shows that this quantity of zeolite can be held by a 30-in. filter with a 5-ft. bed. However, a 30-in. filter will necessitate a higher filter rate than 10 gal. per sq.ft. per minute.

The filter rate is determined as follows: Locate the 5,000-gal. point on the topmost scale and follow the vertical line downward to its intersection with the horizontal line representing a filter rate of 10 gal. (see figures in right-hand margin of the chart).

This intersection falls between the lines (sloping down to the left) representing a 36-in. diameter filter and that representing a 42-in. diameter filter.

If a 42-in. filter is chosen, the filter rate will be 8.5 gal. If a 36-in. filter is chosen, the filter rate will be about 12 gal. per sq.ft. of filter area per minute.

The following is the fundamental formula for determining the depth of the zeolite bed in a filter, being given the cubic feet it is to contain and the diameter of the filter:

$$Depth\ in\ feet = \frac{cu.ft.\ of\ zeolite}{0.785d^2}$$

where d is the diameter of the filter in feet.

It is clear that 23½ cu.ft. of zeolite was necessary to fulfill the conditions of the problem given, and that either a 42-in. or a 36-in. diameter filter be used. To find the depth of bed in a 42-in. filter to hold 23½ cu.ft. of zeolite, proceed as follows: Locate the point representing 23½ cu.ft. on the bottom scale of Fig. 2. The intersection of a vertical line through this point with the diagonal line representing a 42-in. filter falls between the horizontal lines 29 and 30, representing the depth in inches.

By inspection this point is determined to be 29½ in., which is the depth of bed required in a 42-in. filter holding 23½ cu.ft. of zeolite.

Another possibility would be a 36-in. filter with a 40-in. bed (see Fig. 2 for determining the depth of bed).

Table II gives a comparison of the filter diameters which in practice might be selected for the three zeolite types, any one of which would satisfactorily soften 5,000 gal. of 5-gr. water per hour and 20,000 gal. between regenerations.

TABLE II—COMPARISON OF FILTERS FOR 5,000 GAL. OF 5-GR. WATER PER HOUR AND 20,000 GAL. BETWEEN REGENERATIONS
Thirty-Minute Regeneration and 50 Lb. Salt per Regeneration in Each Case

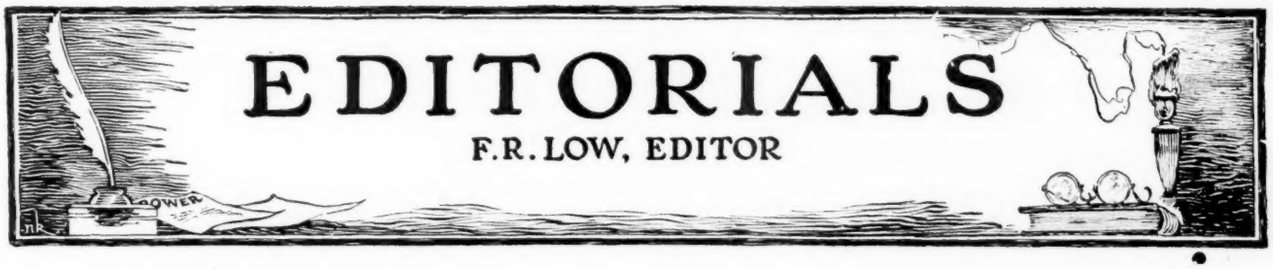
Zeolite	Diameter of Filter, In.	Dept of Bed, In.	Filter Rate, Gal. per Sq.Ft. per Hr.	Cu.Ft. Zeolite	Exchange Value
Green sand	54	28	5	37	2,800
Water-purifying compound	42	16	8½	13	8,000
Clay processed	36	40	12	23½	4,400

The manufacturer designs his filters to fit the zeolite he uses and generally prepares a table of capacities. It is thus possible to select a filter to meet the conditions of any problem without special design to fit the individual case.

It is neither wise nor economical to attempt to purchase zeolite filters under a specification that compels all manufacturers to furnish the filters of the same diameter. Better results will be obtained by specifying the pressure loss allowable, the gallons of water required per hour, the hardness and the number of regenerations per day.

It takes a surprisingly large amount of electricity to evaporate water in an electric boiler. Each kilowatt-hour gives up 3,415 B.t.u. To produce saturated steam at 100 lb. gage from feed water at 200 deg. F. requires 1,021 B.t.u. per pound, or 1,021,000 B.t.u. per thousand pounds. Thus an electric boiler of 100 per cent efficiency would take 1,021,000 ÷ 3,415 = 300 kw.-hr. to make 1,000 lb. of steam. At one cent a kilowatt-hour this would cost $3. Yet the generation of steam by electricity is found to be a paying proposition in certain cases where excess hydro power is available and would otherwise go to waste.

Boiler stop valves should have a continuous runway leading to each valve. The runway should be rail-guarded on both sides so that an attendant can follow the hand-railing to each boiler discharge valve in the dark or with the room full of steam.



The Training of Engineers

MUCH interest is now manifested in engineering education. The most comprehensive attempt to study this up to the present time is the work now being done under the direction of the Society for the Promotion of Engineering Education. Several reports, full of valuable information, have already been published by that society. No final report has yet been made.

When engineering was first taught in this country, much stress was placed on mathematics, mechanics and physics. The remainder of the courses consisted of cultural subjects and a few strictly technical subjects. Later on, industries and graduates demanded more specialized training in their particular subjects, and drafting, shop work and highly technical courses, often of an informational character, were added to the curricula of the colleges. These latter have absorbed a large part of the student's time, and his grounding in the fundamentals suffered as a consequence. The impression seems to be gaining that more time in the average four-year course should be devoted to such fundamental courses as mathematics, mechanics, physics and chemistry and that many specialized courses may well be omitted. These highly technical subjects may be taught in graduate courses, which are being attended by increasing numbers of students.

Industry needs highly trained men who are experienced in research methods and who have the ability to pursue it independent of the direction of others. Such training demands greater time in college and greater expense to the students. It seems only fair to expect that such men should be paid higher salaries than the ordinary four-year graduate. Employers however point out that such advanced men know little or nothing of business and are not particularly valuable during their first years. But higher pay must be forthcoming to induce students to put forth the extra effort involved in graduate work.

There is also the question of the financial status of engineers. Many have felt that the engineer has not been paid so highly for his services as he deserves. One remedy would be to limit the number of men entering the profession and to give these fewer men a better training. The crux of this plan would in the first place be the proper selection of boys to enter engineering. No infallable plan has yet been devised to indicate how students may be selected or what standards should be set up to judge a man's fitness to enter college. The present standards of entrance to the colleges have quite obviously failed, as is evidenced by the small percentage of entering students who graduate from engineering schools.

Will the present study of engineering education provide a better method and will it point out a way to raise the economic status of the engineer?

The Case of Supercharging

THE advantage obtained by supercharging in airplane engines has served to increase the interest of the designer and user of stationary and marine oil engines in this principle. It is, however, questionable, if supercharging is advisable when operating at approximately sea level, for the disadvantages are equal if not greater than the advantages obtained.

In aviation the supercharger is necessary to fill the cylinder with the weight of air that the engine would normally draw in at ground level, and is then a means of retaining normal operating characteristics. On the other hand, when a supercharge is used at sea level the normal designed air charge is increased, making possible a greater power output. If this were the whole story, the plan would possess merit, for investment costs per horsepower would decrease with the increase in supercharging.

Even without a supercharge the horsepower output of a well-made oil engine can be as much as twenty-five per cent above the nominal rating. This is because the air-to-fuel ratio is at least twice the theoretical, and sufficient air to burn an additional fuel charge is already contained in the cylinder. It has been stated by some engineers that the fact that an engine smokes on overload indicates the need of a supercharge. In fact, a well-designed engine will carry twenty to twenty-five per cent overload without too much color in the exhaust.

The limitation as to the permissible load is not one of air charge, but the more difficult one to overcome of cylinder-head stresses. Any increase in fuel consumption, with a constant compression pressure, leads to higher gas temperature and greater heat stresses in the cylinder head.

For short peak-load periods supercharging is permissible provided the overload is not carried for more than two or three hours. This is the procedure recommended by one European builder of two-stroke-cycle engines, and under no circumstance does this builder essay to increase the continuous rating of the engine.

Does It Pay?

THE normal motive for a sale is the feeling on the purchaser's part that the goods are worth the price to him, but the influences that may affect a sale are known to be legion. Among them are service rendered or expected, the desire to reward meritorious endeavor, friendship, etc. Service—past, present or future—is gaining increasing recognition as a legitimate factor in determining a sale. It is beyond dispute that service, as such, has a market value that may properly be included in the price of the article with which it is associated.

Such motives as friendship, desire to reward, personal indebtedness, etc., are certainly legitimate where one is

buying for his personal use or for a personally owned business enterprise. Where purchases are made by one acting as agent for others, for example, by an operating engineer or a purchasing agent, all factors other than value received in goods and service should be viewed with suspicion.

The practice of buying with a single eye to the firm's best interest is becoming more and more prevalent. In the "good old days" a salesman's business was dependent to a large extent on his ability to wield the glad hand and lap up liquor with his prospect. It is true that the genial approach, backed by a reasonable show of hospitality, still has its place in securing a sympathetic hearing for the salesman's proposition. But more and more the purchaser demands a showdown on value received before he will sign his name on the dotted line. It is for this reason that the sale of engineering equipment and supplies is now commonly handled by sales engineers or at least by salesmen who have acquired some degree of familiarity with engineering facts.

Yet some of the old tricks still survive. At conventions and other gatherings of engineers it is not uncommon for a few concerns, still trusting in the efficacy of John Barleycorn as a salesman, to paint the town red in lavish entertainment of supposed prospects. The sum spent for dinners, hotel rooms and liquid refreshments is frequently large enough to keep a capable salesman on the road for weeks.

Leaving out of consideration any question of morals, it would be of interest to know how often such methods pay their cost in sales. Undoubtedly, some men are sold in this manner. Other prospects shrewdly accept the free hospitality, at the same time resolving to avoid paying the bill in their purchases. Finally free entertainment of any sort always attracts a lot of hangers on who are not and never will be worth-while prospects. Does it pay?

Firebrick Research

IT IS clearly recognized that the successful use of refractories depends upon two factors—the nature of the refractory and the manner of using it. The American Institute of Refractories, an organization of manufacturers and users, is conducting extensive research in the materials and manufacture of firebrick in both standard and special shapes. The American Society of Mechanical Engineers, in co-operation with the United States Bureau of Mines, is sponsoring an extended investigation into the service conditions prevailing in the use of firebrick in boiler furnaces. These projects are two sides of the same coin, and each will be more valuable to the industry if the two can be correlated.

Refractories do not fail by simple fusion, for it is easy for the manufacturer to make a brick whose melting point is well above the maximum temperature attained in boiler furnaces. The failure of brick is usually due either to spalling or to the erosive action of molten slag in contact with the surface, which fluxes the brick and causes the surface to become sufficiently soft to be swept away by the rapid stream of gas flowing across the face of the brick. In some instances extremely rapid erosion results.

Responsibility for a failure of firebrick is, therefore, a joint burden of the manufacturer and the user. The manufacturer knows how brick is made, what can be done and what cannot be done, but he is not well informed on the conditions under which his brick must serve the user. The user, on the other hand, knows much about service conditions and little about brick-making and characteristics. The user must learn from the manufacturer what materials are available and what it is reasonable to ask for, and, so far as may be, develop modifications of his conditions to make it possible to use readily available materials. The manufacturer in turn must learn from the user the conditions under which brick must work and devote serious effort to the development of brick better adapted to the needs of industry.

The American Refractories Institute affords a splendid opportunity for the manufacturer and user to co-operate, and it is earnestly to be hoped that the manufacturers will admit the users to the inner councils of the Institute, giving them an active share in the planning and direction as well as in the conduct of so valuable a study.

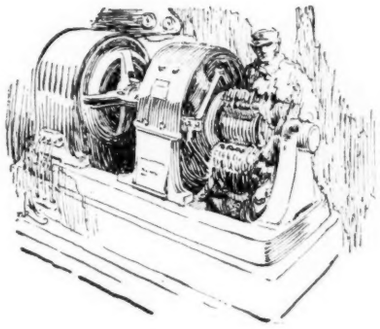
Building for the Future

ONE OF the handicaps that the Federal Water Power Commission is laboring under is the lack of information on the various rivers of the country. There are now pending applications for twenty-five projects on the Tennessee River and two of its tributaries. These projects range in size from about twenty to one hundred and fifty thousand horsepower and represent an aggregate of about one and one-half million horsepower, which is only about one-half of the total power on the Tennessee. Without information obtained from careful surveys and studies of these rivers, it would be impossible to pass intelligently upon these permits. Fortunately, the government has been surveying and studying the Tennessee River for a number of years and has more complete information on it than it has on any other water way of similar type in the country.

Where there are a number of power sites on the same river, they should be considered as a correlated project and not individually, if the maximum head is to be utilized and the greatest power obtained. If the plants are not properly located, it is possible to create a low-head project that will not be economical to develop alone, but which might have been absorbed into another development. A dam at one site may be made high enough to flood out part of another project farther upstream and make it uneconomical to develop at some future date. On many rivers the question of navigation must be considered along with that of power development. Before any one of the projects can be developed, the effects on the other developments should be known.

If our water powers are to be developed to the best advantage, this can be done only when reliable information is available on the rivers where power is to be produced. The survey that the federal government is making of the Tennessee River furnishes a good example of what is needed on other rivers and why. Water-power equipment has been brought to a state where these plants are no longer built for today alone, but for the future. Mistakes made in the projects developed now, will be exceedingly difficult to correct in the future on any economical basis, therefore it behooves those interested in water power to make every effort to avoid improper developments.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for October will be announced next month.

Power is pleased to announce the awards of the judges for the first and second prize contributions received during September for this department in accordance with the terms of the contest as stated above.

The first prize of $25 goes to J. A. Madsen, of Chicopee, Mass., for his article on "Saving Fuel in Textile Plants," in the Sept. 22 issue.

The second prize of $15 goes to H. M. Smith, of Noyes Island, Alaska, for his article on "Rewinding Burned-Out Field Coils with the Old Wire," in the Oct. 13 issue.

The judges were: (Chairman) D. L. Fagnan, formerly refrigerating engineer, and more recently associated with the Smoot Engineering Corp., New York City; Norman N. King, chief engineer, Singer Bldg., New York City; and Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City.

Two Ways of Connecting Alternator's Exciter

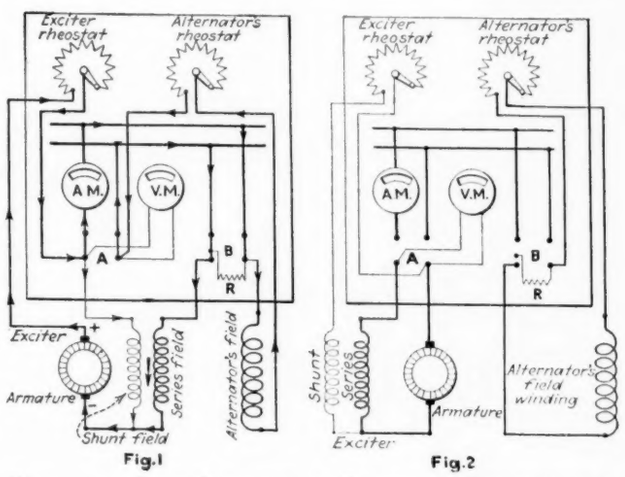
That some small power plants operate at all seems more remarkable than that they occasionally have some trouble. I was recently called by the owner of a small plant in a neighboring town to help locate his trouble. The plant consisted of an oil engine belted to a three-phase 2,300-volt alternator with an exciter belted from the alternator shaft. The operator said that the exciter shunt-field rheostat had overheated and burned out.

A test of the rheostat revealed an open-circuit between two adjacent segments; these were bridged with copper wire, after which the engine was started and brought up to speed. With no load on the exciter the rheostat controlled the exciter voltage over a range of from 20 to 140 volts, in an apparently normal manner, but when the alternator-field circuit was closed, the exciter-field rheostat heated dangerously.

Checking over the excitation wiring, which was in conduit from the exciter to the switchboard and from the switchboard to the alternator, revealed connections as shown in Fig. 1. These connections put the exciter-field rheostat in series with the alternator-field rheostat when the alternator is excited. With the switches open the connections are such that the exciter would seem to operate normally.

According to the plant owner's and the operator's statement the switchboard wiring was exactly as installed by the manufacturers' erector, who installed the complete plant some four years ago. They further stated that the erecting engineers' operating instructions were, when starting up the plant, to close both excitation switches, *A* and *B*, and with all resistance cut in both exciter- and alternator-field rheostats, bring the unit up to speed, then cut out all the resistance in the exciter-field rheostat and sufficient in the alternator-field rheostat to get the proper voltage and to control the alternator's voltage entirely with its field rheostat. It seems that this operating procedure had answered the purpose more or less successfully for the last four years.

Recently, from some cause the original exciter armature had burned out, was sent away for repair and a borrowed exciter installed for temporary use. This borrowed exciter was of double the rating of the old one, and the pulley ratios were such that it was running about 10 per cent above rated speed. When the plant was started up under the usual operating procedure with the borrowed exciter in service, with all resistance in the alternator-field rheostat, the alternator's voltage was over 3,000 volts. Attempts to reduce the voltage by cutting resistance in the exciter-field rheostat passed the entire excitation current through it and the rheostat being of relative small current-carrying capacity, it overheated.



Figs. 1 and 2—Incorrect and correct connection for exciter circuit

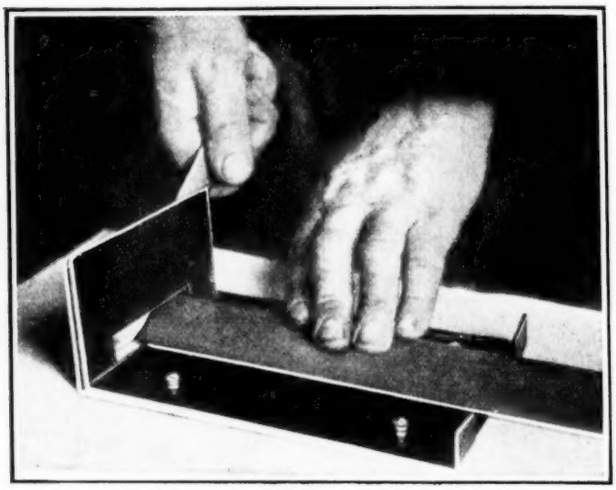
It will be noticed that with the excitation switches *A* and *B* open, Fig. 1, the direct-current voltmeter was in series with the alternator's field and discharge resistance *R* the alternator's field and its rheostat. Also that in operation under load the exciter was working at its maximum voltage so far as the shunt-field circuit was concerned, since the shunt-field rheostat was always set with all resistance cut out. This is not intended as a knock on manufacturers; erecting engineers are usually competent men, but if this plant owner's statement was correct that the installation was originally made as shown in the diagram, this particular erector certainly had ideas all his own. An hour's work rewiring the excitation circuit as in Fig. 2 remedied the trouble. In this diagram it can be seen that the exciter can be controlled independently of the alternator's rheostat, and this makes it possible to build the voltage up on the exciter before closing the switches to the alternator's field winding. J. H. BENDER.

Clayton, N. M.

Squaring the Ends of Belts

A belt repairman who never could keep a square on the belt-fixing bench because it was always being borrowed by other workmen, determined to devise some other tool for squaring the ends of belts that would be of no use for any other purpose. The result is shown in the illustration.

Two pieces of sheet metal are used, both bent up at one end and cut away in the center at the bottom to take the belt. The top piece is also bent up slightly at the other end and cut away as shown in line with the opening at the opposite end. Four screws are used to hold the device to the bench, and these are put in with their sides in line with the side of the slots. Just sufficient space is left between the upturned section of the



Tool used in place of a square

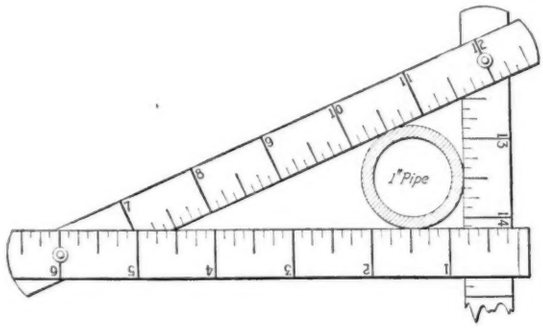
plates to allow passing the knife down to cut off the belt.

In use the belt is slipped through the slots and is held up against the sides of the slots to keep it square while the end is cut off. Belts up to 4 in. in width can be cut in this particular fixture, but the size, of course, could be increased to accommodate larger belts if desired. ARTHUR HENDALL.

Montreal, Canada.

Calipering Pipe with Folding Rule

An ordinary $\frac{5}{8}$-in. wide folding rule may be used to caliper the diameter of pipe by knowing or referring to a table showing the readings on each part of the rule where they meet on placing the rule around the pipe as shown in the illustration. Place the rule against the pipe so that the markings on the rule's edge lie next



Folding rule placed around pipe to obtain pipe diameter

to the pipe and by using the following table and noting the figures on the rule at the angle formed by the first and third lengths of the rule, the inner diameter of the pipe may be known.

Dimension Indicated By Rule	Pipe Diameter	Dimension Indicated By Rule	Pipe Diameter
$\frac{1}{4}$x12$\frac{3}{4}$	$\frac{1}{8}$	$\frac{3}{4}$x14$\frac{1}{8}$	1
$\frac{3}{8}$x13	$\frac{1}{4}$	1 x14$\frac{3}{4}$	1$\frac{1}{4}$
$\frac{1}{2}$x13$\frac{1}{8}$	$\frac{3}{8}$	1$\frac{1}{2}$x15$\frac{1}{2}$	1$\frac{1}{2}$
$\frac{1}{2}$x13$\frac{3}{8}$	$\frac{1}{2}$	1 x16$\frac{3}{8}$	2
$\frac{5}{8}$x13$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$x18	2$\frac{1}{2}$

North Bend, Neb. G. G. MCVICKER.

Why Did the Steam Fail to Heat?

Occasionally, problems have to be solved by methods that are directly opposed to engineering theory and even the men effecting the solution use these methods as a last resort, without knowing just why they work satisfactorily. As an example, there is a plant in this vicinity in which one or two rooms must be kept heated to avoid freezing. During the week the exhaust from the engine at 1 lb. pressure kept them at a high enough temperature so that no trouble was experienced, but when supplied with live steam at 8 lb. pressure over the week end, frequently the water pipes were frozen up.

Looking at the problem from the theoretical side, the live steam at 8 lb. pressure and 235 deg. temperature should have raised the room temperature higher than did the exhaust steam at 1 lb. and only 215 deg. temperature. The plant engineer at once assumed that the steam was superheated after leaving the reducing valve, but a thermometer placed in the line near the coil inlet showed saturation temperature. Why, then, was not the increased temperature difference under this method of heating more effective?

An old engineer from a near-by laundry came into the plant one Sunday and laughed when the problem was put up to him. "I'll heat that room with 1 lb. pressure and you'll have no freezing if you follow my advice." Being given full authority to tackle this problem, he used a method that none of the engineers

in that plant had ever heard of and they were frankly skeptical.

There was an engine of 50 hp. capacity belted to a small direct-current generator to provide emergency lighting service, and he at once ordered that the exhaust be piped to the low-pressure side of the reducing valve. When the engine was started and exhausting into the coil, the lighting load was not sufficient to maintain over 1 lb. back pressure and enough lights were turned on to keep the load high enough to prevent the pressure falling below 1 lb. This solved the problem, and everyone at once was interested in learning the explanation of this phenomenon. "Well, boys," said the old engineer, "I've done this trick more than once; I can't explain why it works, but I know that it will work in many cases. My own opinion is that the exhaust steam entering in puffs instead of in a steady flow, causes vibrations in the walls of the pipe which increase the heat transmission, but there may be some other explanation of this kink. Some day when you have time, try this experiment with a piece of ice and a bowl of water. Place the ice in the bowl and see how long it takes to melt it. Now take a similar piece of ice and place it in a covered bowl and shake the thing rapidly for one minute. You'll find that you've melted as much ice in one minute in the second case as you did in 20 minutes in the first case. That's all I can tell you about it, boys." A. F. SHEEHAN.

Brightwood, Mass.

[In all probability the pulsation of the engine exhaust served to sweep the water film from the pipe wall and so decreased the resistance to heat flow.—Editor.]

Why an Oil Engine Ran Away

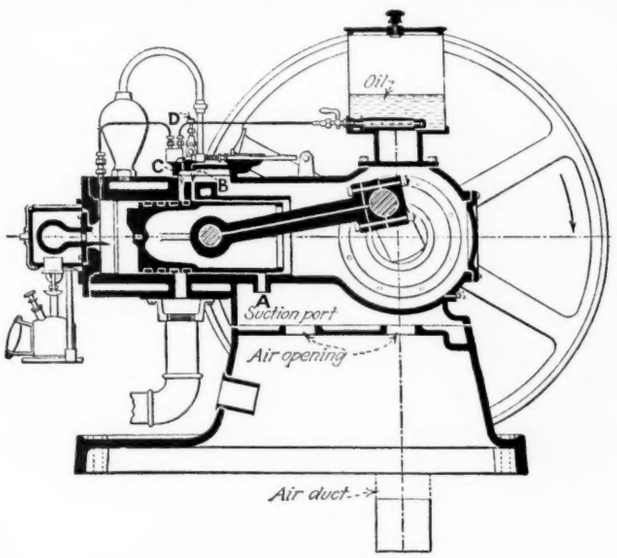
In the power laboratory courses of engineering schools the students not only apply theory in practice, but are also taught to handle the machine in operation and to handle themselves in the presence of operating machines. It is only natural that the machines should suffer much abuse; consequently, the operating problems of laboratory instructors are numerous and of the most practical kind.

One laboratory engine that developed trouble was a 12-hp. horizontal Mietz & Weiss oil engine, running at 300 r.p.m. The engine behaved beautifully for some time, but suddenly developed trouble and froze the piston. It was allowed to cool, then pried loose with a crowbar and started again, only to freeze repeatedly. The engine was then disassembled, the bearings inspected for tightness, cylinder and piston carefully examined and calipered. The cylinder and piston seemed in good shape; neither was scored or gummed up. This type of engine seldom gums up, because of the use of steam that is generated in the water jacket of the engine and is mixed with the air entering the cylinder. The clearance between the cylinder and piston, although large, did not seem sufficient to prevent the piston from freezing at the operating temperatures.

It was decided to increase this clearance by cutting $\frac{1}{64}$ in. from the piston barrel, using new piston rings. It was soon evident after the engine was again started, that it was running wild, and the fuel pet-cock was immediately closed. The engine, instead of stopping, as was expected, continued to run at an increasing speed, there being no way of stopping it. Suddenly, of its own accord the engine stopped.

Examination showed that the engine shook itself loose from the baseplate, crumbled the foundation and even split the cast-iron washers on the anchor bolts. The only broken piece on the engine itself was the copper tube connecting the lubrication reservoir to the sight-lubrication metering pin *D* controlling the piston lubrication. The cause of the engine's running wild with its fuel shut off seemed mysterious until an examination revealed that it was operating on lubricating oil.

This type of engine operates on the two-stroke cycle. The piston uncovers *C* the air inlet and *B* the steam port leading to the cylinder, and the suction port *A* leading to the crankcase. Under operating conditions the action is as follows: With the piston on its firing or working stroke it compresses the entrapped air in the crankcase to about 2 lb. pressure. The exhaust port opens first, allowing the cylinder pressure to drop



Cross-section of engine that ran away

to atmospheric pressure. Shortly after, as the piston continues to the right, the air-inlet port *C* opens through which the compressed air from the crankcase rushes into the cylinder, first striking the lip on the piston, thus causing the air to sweep part of the burnt charge from the cylinder. As the piston continues to move to the right, the pressure in the cylinder becomes less than atmospheric, and the cylinder is filled by the air and steam from the crankcase and the steam dome. On the return stroke steam and air continue to flow into the cylinder until the piston and rings cover the ports. The entrapped air and steam mixture is then subject to compression. The engine receives its fuel through the injection nozzle early in the compression stroke. The piston is lubricated on the suction stroke, and with the piston to the extreme right, it still covers this oil port.

As the steam port, air port and oil port were all subject to the same pressure existing in the air passage, which on the suction stroke is less than atmospheric, the atmospheric pressure acting on the oil reservoir outside forced the oil through the sight-lubrication metering pin, and thus oiled the piston. There was enough clearance around the turned-down piston to allow the lubricating oil to pass by the piston and rings into the cylinder. The oil probably collected on the scavenging lip and was then sprayed off for suitable combustion by the inrushing air and steam.

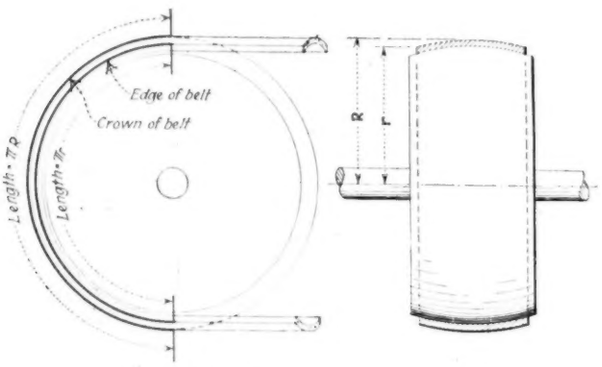
College Station, Pa. A. J. NICHOLS.

Comments from Readers

Concaving the Idler Pulley Stops Excessive Wear

Referring to the letter by Roger F. Wiley in the Sept. 8 issue, there is one point that is worth bringing out where the idler is made concave to match the convex pulleys as follows:

Owing to the convexity of pulleys as shown in the illustration, the circumference at the largest diameter of the pulley is naturally greater than the circumference at the edges of the pulley. Thus, in the accompanying illustration, which is somewhat exaggerated purposely, the length of the belt at the center wrapped halfway around the pulley, or through 180 deg., would be equal to πR, where R is the radius at the point of maximum diameter. At the edges the length of the belt would



Illustrates difference in length of edge and crown of belt

be only πr where r is the radius at the edges. Thus, if the difference in radius should be as much as 1 in., the length at the center would be 3.14 in. greater than at the edges. If the other pulley has the same curvature of crown and if it is the same size, the difference in length would be 6.28 in.

Now if in addition to this we use an idler pulley that is concave as shown by Mr. Wiley, there is less additional stretch of the center fibers than where a convex idler is used.

Regarding Mr. Wiley's argument that there is less bending of the belt where a concave idler is used, I believe that to be of less importance than the difference in velocity of the center and edges due to the difference in radii, as previously explained.

Newark, N. J. W. F. SCHAPHORST.

Having had considerable experience with belt drives, I do not agree that the idler should be concaved. I have charge of four air compressors, each of which has a belt drive similar to the one shown on page 376 of the Sept. 8 issue, except that the belts are 20 in. double leather. The motor and compressor pulleys are crowned, but the idler is straight. The first compressor was put in operation Sept. 22, 1916, and is still running with the belt that came with the machine. The other three compressors were put into operation February, 1917, February, 1918, and January 1, 1920 respectively, and are running with the original belts. Therefore, I do not think that the straight idler causes any undue wear on the belts, or they would not be running that length of time. J. L. FRYE.

Sharon, Pa.

Compulsory Systems of Weights and Measures

I have read with much interest the Foreword by Mr. Low in the Aug. 18 issue on "Compulsory Systems of Weights and Measures" and feel that I cannot agree with him. All European countries with the exception of Great Britain and Russia, which latter is only semi-European, have passed through the same state of transition and experience proves that the difficulties, although not inconsiderable, certainly can be overcome, and the quicker the United States lines up the better for all concerned. There can be no doubt, I suppose, even among the most ardent supporters of the British system of measures and weights, that the metric system is much easier to figure on, and I do not think there will be anybody in the United States who will consider the British system of coins, which nevertheless is completely in line with the British system of measures and weights.

Of course the older system continued to live among the people, especially the names of some of the older units, but their values have been rearranged to fit into the metric system. For instance in Norway the "alen" (2 ft.) is still greatly used when buying cotton, linen and woolen material, but its old value has been changed slightly and is now 60 cm.; also "kande" is much used in the household, but it has been changed somewhat and is now exactly 2 liters, and no doubt similar things could and would be done in the United States. For instance, a gallon might become 4 liters, and the liter could just as well be called a quart and so on.

I think it is a great pity for the progress of mankind that certain interests, for instance, the cotton weaving industry in Great Britain and the machine industries, automobile industry, etc., in the United States, are so energetically counteracting this great improvement. There can be no doubt that the metric system is a great improvement on the British, and as the world cannot go backward, and as there is no better one existing at present, the only logical thing to do is for Great Britain and the United States to line up. Certainly, it will save much time for anybody having to use it. But it would appear that conditions in the United States have proved that the only way to obtain a quick and thorough change will be by compulsory legal enforcement. OTTO KAHRS.

Christiania, Norway.

Brine Tank for Cooling Coils

In the Oct. 6 issue of *Power* R. L. Tullis invites comments as to the plan of putting cooling coils in a brine tank.

He is quite right in stressing the inconvenience experienced with the frosting coils in the storage rooms. It is one of the bugbears of the operating engineers and often a cause of friction between the engineering force and the department officials, who perhaps do not realize the importance of clean coils and object to having the storage rooms disordered by the removal of the snow.

However, I do not think that the method described would accomplish the desired object. In our plant there is a brine cooler situated in a storage room, which is kept at a temperature of from 20 to 22 deg. F.; the brine cooler is at a temperature of from —10 to 0 deg. F. The surface area of the cooler is about one-sixth the floor area of the storage room. At week ends the brine cooler is left undisturbed for a period of about 40 hours, and I have noticed that there is not one degree rise in the temperature of the brine during this time, and also the temperature of the storage room will rise if the expansion valve is shut off its evaporating coils.

The reason that there is no flow of heat to the cool brine, is that for practical reasons the brine has to be kept a little lower than the top of the brine cooler, and thus a well of cool, dense, or heavy air is formed in the space above the brine to the top of the tank. This prevents the warmer and less-dense air of the storage room from coming into contact with the surface of the brine, so that no circulation of air takes place and therefore no cooling action.

The combination of brine and evaporating coils has been adopted in a different form and is in certain specific cases useful. An example of this is the cool-air system, whereby air is forced by means of a fan through a bank of evaporating coils over which brine is sprayed. A complete closed circuit of the air takes place, as after leaving the bank of coils, it is led by ducts to the storage rooms, discharging into one side and drawn across to the ducts on the opposite side, which lead to the suction side of the fan.

Toronto, Canada. RALPH LILL.

Auxiliary Exhaust Valves for Unaflow Engines

The discussion by A. D. Skinner in *Power* Nov. 3, on the proper position for auxiliary exhaust valves, is interesting and serves to point out that save for special conditions compound engines are not economical. However, he has made several arguments for which there is no sound basis, and these should be challenged.

One of the early points made is that the mechanical efficiency of the unaflow is superior to that of a cross-compound engine. It is, but the difference is very small. Compared to the tandem compound the unaflow is not superior, as has been proved by Sulzer tests. This is for the reason that the bearings, etc., must be much heavier in the unaflow.

Entirely too much stress is placed on the condensation taking place with a large clearance. It is admitted that in an engine when the compression is not carried up to the live steam pressure and when no jacketing is used, there is a cooling action on the live steam, and the greater the clearance surface the greater is the loss. But if there is any merit in steam jacketing, the clearance volume surfaces are always as hot as the entering steam and initial condensation cannot occur, for the jacketing is usually ample to cover the clearance volume. Professor Nagel's experiments show that the metal surface of the clearance volume changes its temperature but a few degrees during the cycle, and that the compression steam temperature is equal to that of the live steam. To talk of initial condensation under such thermal conditions is contrary to engineering logic.

The real reason that with a large clearance steam consumption is high is due to the small number of expansions. For example, with 4 per cent clearance the number of expansions can be greater than with 14 per cent. The steam consumption is of course lower with the greater number of expansions.

Since the only disadvantage in having the auxiliary exhaust valve in the head is the claimed transfer of heat from the head and valve cage to the exhaust steam, it is well to refer to Professor Nagel's experiments a second time. He found that the head temperature was practically constant at 300 deg. F. and the piston-head temperature was 295 deg. F. If it be true that the steam sweeping across the cylinder head on its way through an exhaust valve placed at the end of the cylinder absorbs heat from the metal, it is equally true that in flowing to the valve placed along the cylinder barrel the same heat loss is experienced, for the steam path is across the face of the piston. The valve placed in the head does not appear at a disadvantage. But can the exhaust steam really absorb much heat from the heads and other parts? It has been shown that in the Nagel experiments the cylinder head was at 300 deg. F. temperature. At atmospheric back pressure the steam in the cylinder, after the piston uncovers the exhaust ports, has a temperature of, say, 212 deg. F. Its possible increase would be $300 - 212 = 88$ deg. F. The steam is dry saturated inasmuch as the initial flow through the exhaust ports will carry all moisture with it. The steam would become superheated in passing through the auxiliary exhaust port, the specific heat being approximately 0.5 B.t.u. In other words, each pound of steam passing through the auxiliary valve could remove only 44 B.t.u. This is equivalent to the latent heat in approximately $\frac{5}{100}$ lb. of steam. But as only 67 per cent of the steam fed to the engine passes the auxiliary valve, the heat lost becomes less than $\frac{4}{100}$ of the steam flowing to the engine. If the steam consumption per horsepower-hour be 18 lb., the existence of auxiliary exhaust valves in the head or elsewhere could not increase the consumption more than 0.6 lb. per horsepower-hour.

The real objection to the exhaust valve in the head is the likelihood of leakage. This is easily overcome by proper design. If one of the valve seals be made flexible, changes in temperature will cause no ill effects.

In the discussion Mr. Skinner has considered only the poppet-type auxiliary valve. Why not use a piston valve? If this is done, the objection to a high reaction upon the valve gear disappears, as the excess pressure acts radially inward and the valve can be reinforced to prevent distortion. The speed of valve closing can be made very high, for the seal is by a wiping action and there is no hammer blow.

One objection to the placing of the auxiliary valve

along the cylinder bore should be mentioned. The auxiliary valve closure is accomplished by the piston overriding the cavity. If this compression is suitable for atmospheric back-pressure conditions, it is too early when a back pressure of, say, 20 lb. gage is carried. The placing of the valve at the end of the cylinder permits a variation in the time of closure to suit conditions.

After all, the ideal and eventual engine will have a steam jacket over the entire cylinder and the piston will be also steam heated. With such an arrangement an engine may be operated on the saturated steam line during the entire stroke, making the output per unit cylinder volume greater than at present, reducing the first cost without sacrifice in economy.

Jersey City, N. J. JOHN CASSIDAY.

The Refractories Investigation

The article "Preliminary Findings in Refractories Investigations—Part II," by Helser and Bole, appearing in the Aug. 25 issue, contains some statements with which we cannot agree and which are of sufficient importance to warrant a thorough discussion. These appear on page 279 and define various classes of firebrick by giving definite limits to their behavior in several tests. They are presented as requirements and, coming from a federal bureau, will undoubtedly be used by some consumers as specifications. We believe their acceptance as such would be decidedly ill-advised.

In Part I of the article the nature of the work, its purposes and the plan of attack are all described. Part of this plan involves determining as definitely as possible the principal factors governing the failure of refractories in various types of installations, subjecting these factors to a detailed experimental analysis, and undertaking the formulation of tests that will measure the suitability of the tested material for the given conditions. This plan is well conceived and a logical one to follow, particularly because of the fact that service conditions are given full recognition and suitability tests based on service conditions are to be formulated.

The specifications that are proposed appear to be premature in view of the fact that complete information on service conditions has not been obtained. There is also no apparent attempt to correlate the specifications with known service conditions. On page 235 of Part I of this article it is stated that "it was not apparent that distortion under load was a clearly defined cause of failure in any installation inspected," and yet in the specification dealing with flint clay refractories (and these comprise almost 100 per cent of those used in boiler linings) it is stated that "first quality ware, when subjected to a load of 40 lb. per sq.in. should not compress more than 5.5 per cent when heated to 1,350 deg. C. in 4½ hours and held at that temperature for 1½ hours." According to the authors' own argument, load test specification is unnecessary, for in discussing plastic-clay refractories they state that "inasmuch as brick of this type are not used in service requiring hot load carrying capacity, no load-resisting requirements are made. Brick seldom fail from this cause when only one face is exposed to the heat."

It appears to us that the tests suggested are those which classify firebrick rather than "suitability" tests, as suggested in the first part of the article. Even so, we do not believe that the tests have been properly chosen. It can readily be proved that brick containing a higher proportion of certain plastic or bond clays than is customarily used and that are finely ground and hard burned will meet the load and reheating test requirements much better than the usual flint-clay firebrick and will also pass the fusion point requirement. R. F. Geller, of the United States Bureau of Standards, in "The Laboratory Testing of Aluminous Refractories"[1] calls attention to this fact by stating that " . . . it is well known to manufacturers of refractories that a brick of many inferior qualities can be so made as to withstand satisfactorily the test for deformation under load at high temperatures."

It does not necessarily follow that brick that meet the load test specified will be satisfactory or that those that will not meet it will be unsatisfactory. There are numerous references in the literature to show that deformation under load is a function of burn and grind and the denser and harder the product the less will be the deformation. However, it is also well known that finely ground and hard burned brick, even though made from high-grade clays, do not resist spalling to the degree that would be necessary according to the authors' own statements. They point out on page 235 that spalling "was apparently a major factor in refractories' failure in oil-fired furnaces, in sprung or suspended arches, in leaning walls, and in a few cases in vertical side walls."

For the same reasons as herein outlined, we believe that the expansion limit of ½ per cent upon reheating to 1,400 deg. C. is too rigid. When the reheating test was first proposed, a limit of 1 per cent was adopted in the belief that the expansion was caused by inferior clays. It has since been found that this is in most cases not true, and further that there is no definite relation between expansion and service.

If for no other reason the requirements listed would be illogical because of the fact that they would exclude many brands of flint-clay firebrick that are known to give good service in boiler settings. In an article written by Geller,[2] of the United States Bureau of Standards, it was shown that of nine brands selected as having good reputations for boiler service, two had greater deformations in the standard load test under a load of 25 lb. per sq.in. than is permissible in the requirements cited, and several others gave results sufficiently high to make it practically certain that they would have exceeded the limit if a load of 40 lb. per sq.in. had been used, as has been recommended in the article under discussion. It is evident, therefore, that the authors have failed to follow their stated plan of formulating tests that will measure suitability.

A number of other discrepancies are noted in the article, one being the statement that high alumina refractories deform readily at elevated temperatures. Further reference to the article by Mr. Geller on the "Laboratory Testing of Aluminous Refractories" will show that in the case of the tests made by him high alumina brick do stand up very well under load. Mr. Geller's results in this respect have also been checked by tests made in other laboratories and the same general conclusions reached.

M. C. BOOZE, Senior Fellow,
Refractories Fellowship,
Pittsburgh, Pa. Mellon Institute.

[1] Journal of the American Ceramic Society, 7, 667 (1924).
[2] "Testing of Fire Clay Brick with Special Reference to Their Use in Coal-fired Boiler Settings," U. S. Bureau of Standards Technologic Papers 279, page 120.

Questions and Answers

Conducted by

Franklin Van Winkle

Brass Bushing for Feed Connection

Why is a brass bushing necessary for connecting a feed pipe to a boiler in place of making the connection by direct tapping for the feed-pipe size? R. G.

The purpose of using a bushing is to obtain a larger tapping into the boiler and stronger hold of the screw threads, to resist the constant jarring of the feed line and connections. The bushing is preferably made of brass because the material is less corrosive than iron, and being softer than the boiler material, the screw threads of the bushing more readily adapt themselves to those of the boiler tapping.

Cleaning Injector Tubes

How can an injector be cleaned of mud and scale without injury to tubes? W. P. A.

If the parts are not readily separated on account of corrosion, submerge the injector in kerosene for a few hours. Remove the tubes from the body of the injector and cleanse them of any grease by washing in a strong solution of potash and water and, after washing in clean hot water, dip the parts in a solution of 1 part of muriatic acid to 10 parts water, but only for a long enough time to soften the scale, after which the tubes should be washed in clean water to stop the corrosive action of the acid. After the tubes have been cleaned nearly down to the finished surfaces with any convenient tool, complete the cleaning with a scraper made of hard wood so as not to mar the original surfaces or change the form or dimensions of the tubes. Spots or patches of scale not readily removed should be softened by local applications of the acid solution, taking care after each application to wash the tube clean.

Reboring Counterbore of Engine

In reboring an engine cylinder, the diameter of the main bore would be increased nearly to the diameter of the counterbore. Would it be necessary also to rebore the counterbore? G. N. H.

After reboring the cylinder, the counterbore should be as much larger than the main bore as necessary to insure against wearing down of the main bore to the side of either counterbore. The purpose of the counterbores is to form a limit to the length of the main bore, so the piston may override the ends of the main or working bore and prevent the piston from wearing shoulders in the cylinder at each end of its stroke. Such shoulders would be an obstruction to the piston any time there might be a change in the length of the connecting rod from keying up or from adjustment of the length of the piston rod, and when the piston is fitted with packing rings, the presence of only a small shoulder is likely to result in breakage of the piston rings.

Eccentric Flange Coupling

What is the purpose of using an eccentric flange coupling on a steam line, and how would the flanges be placed? J. F. B.

The purpose of an eccentric flange coupling is to obtain an offset in the center lines of pipes joined by the coupling and is most commonly used as a reducing coupling on a horizontal steam pipe line that is pitched to drain from the larger to the smaller pipe. Complete drainage then may be obtained through the coupling by having the bottom of the smaller pipe at the same or lower level than the bottom of the larger pipe in the concentric flange.

Changing from Condensing to Non-Condensing with Back Pressure for Heating

What changes of valve setting of a Corliss engine should be made when changing from condensing to non-condensing with back pressure for exhaust-steam heating? H. M. A.

For running non-condensing the exhaust valve should be closed later as less compression of the higher-pressure exhaust will be required for obtaining the same cushioning for the piston. With a double-eccentric Corliss valve gear, less compression is obtained by setting the exhaust eccentric backward. With a single-eccentric Corliss engine it will be necessary to set the eccentric backward and then, to obtain the same lead as before, the steam-valve rods must be adjusted to give less lap when the wristplate is in central position. The valve setting should be determined from indicator diagrams, but in any case there should be no more compression than necessary to insure smooth running of the engine.

Five-Ported Valve Seat of Duplex Pump

Why is the steam valve seat of each side of a duplex steam pump provided with five steam ports? M. L.

Ordinarily, the steam distribution of a duplex pump is accomplished by a D form of slide valve with outside admission. In place of the valve seat having a central exhaust port and one port with steam for each end of the cylinder, there are two ports and connected steam passages at each end, making five ports in the valve seat. At each end of the cylinder the outer port acts as the steam admission port and the steam passage connected with this port terminates at the end of the cylinder so as to guide the incoming steam behind the piston. The other ports in the valve seat between the steam admission ports and exhaust port, are each connected to the cylinder by a passage that terminates a short distance from the cylinder head of the same end to act as an exhaust port, which communicates with the central exhaust port of the valve seat when exhaust is taking place, just as with the

ordinary D slide valve. The piston in approaching the end of the cylinder during an exhaust stroke covers this exhaust passage, and by preventing further escape of steam to the exhaust the steam then remaining in the cylinder is compressed, thus forming a cushion to bring the piston gradually to rest without striking the end of the cylinder.

Quality of Steam After Passing Through Reducing Valve

If steam of 400 lb. gage pressure is passed through a reducing valve and the pressure is reduced to 300 lb. gage, what change, if any, will take place in the steam if it had originally 2 per cent of moisture? *H. J.*

By interpolation of Marks and Davis steam tables it may be seen that one pound (weight) of steam at 400 lb. gage, or 415 lb. per sq.in. absolute, contains 426 B.t.u. heat of the liquid, and the latent heat of evaporation is 781.5 B.t.u. When the steam contains 2 per cent moisture, then only 100 — 2 = 98 per cent of the total weight of each pound present has received the latent heat of evaporation. Hence, the total heat contained per pound would be 426 + (98 per cent of 781.5) = 1,191.8 B.t.u.

When this steam is passed through a reducing valve, all the heat is retained by the steam at the lower pressure except the small loss from radiation, since the work performed in expanding to a lower pressure is converted into heat. Hence, each pound of the steam at the reduced pressure of 300 lb. gage, or 315 lb. per sq.in. absolute, may be regarded as containing 1,191.8 B.t.u. The steam tables show that a pound of dry saturated steam at the pressure of 315 lb. per sq.in. absolute should contain 1,204.7 B.t.u. and containing only 1,191.8 B.t.u. there would be a shortage of 1,204.7 — 1,191.8 = 12.9 B.t.u. Interpolation of the steam tables shows that a pound of dry saturated steam at the pressure of 315 lb. per sq.in. absolute between values for 310 and 320 lb. gives heat of the liquid 397.5 B.t.u. and that the latent heat of evaporation is 807.1 B.t.u. The shortage of 12.9 B.t.u. indicates that only $\frac{807.1 - 12.9}{807.1}$ or $\frac{794.2}{807.1}$ part of the pound of wet steam has received the latent heat of evaporation, and therefore the quality of the steam at the reduced pressure would be (794.2 × 100) ÷ 807.1 = 98.4 per cent dry; that is in the new condition there would be 100 — 98.4 = 1.6 per cent moisture present.

Defrosting Expansion Coils

In defrosting expansion coils is it the quantity and temperature of the hot gas circulating through the coils that does the work, or is it the gas pressure? *F. S.*

The reason that one can defrost coils by circulating hot gas is that the temperature difference between the hot gas and the snow on the outside of the coil causes a transfer of heat from the gas to the snow, and the latter melts. The amount of heat transferred depends upon this temperature difference and upon the amount of heat in the gas. The greater the weight of gas circulated through the coil the greater is the amount of heat that the existing temperature difference can cause to flow through the pipe to the snow or frost. The temperature of the hot gas is due to the work of compression in the compressor. The higher the discharge pressure of the machine the greater will be the gas temperature. Consequently, while the direct cause of the defrosting is the temperature and weight of gas passing through the coil, it is apparent that the temperature in turn depends upon the pressure. However, it would be possible to compress the gas to a few pounds and then by heating the pipe line raise its temperature as high as desired.

"B" Slide Valve

What is a B slide valve, how does it differ from a D slide valve and what is the advantage of a B valve over the ordinary D slide valve? *H. A. S.*

The designations D slide valve and B slide valve are commonly employed according to the resemblance of the valve section to the letter D or B as the case may be. In the illustrations, Figs. 1, 2 and 3, the valve sections are shown with cross-hatching. The ordinary

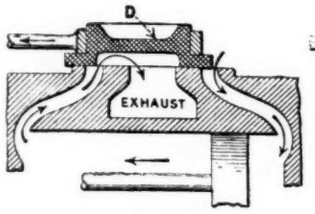


Fig. 1—D slide valve

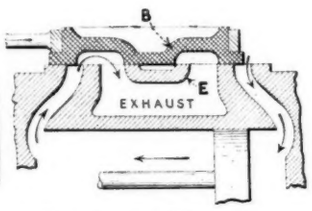


Fig. 2—B slide valve

D slide valve, *D*, Fig. 1, has a single exhaust cavity on the bottom for alternately connecting the cylinder ports of opposite ends of the cylinder with the exhaust passage, while with the ordinary direct B slide valve, as shown at *B* in Fig. 2, the middle of the valve is supported by a bridge *E*, which covers part of the exhaust passage.

The advantage of the B form is that the cylinder steam ports may be farther apart, permitting of shorter steam passages and less cylinder clearance due to shorter steam passages than with the D form of valve, and as the portion of the valve that covers the cavity in the bridge *E* may be connected with steam at the steam-chest pressure, this form of valve may be designed to offer practically no more frictional resistance from difference between steam chest and exhaust pressures than the shorter D valve. Another form of B

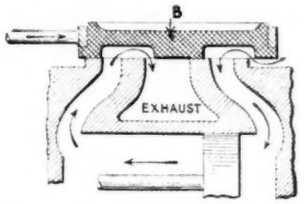


Fig. 3—Indirect B slide valve

valve is shown at *B* in Fig. 3, in which steam is admitted under the ends of the valve. In this form it is an indirect valve, since for admission of steam, in the beginning of a stroke of the piston, the valve rod and valve must be moved in a direction opposite to the motion of the piston, as indicated by the arrows.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Hydrogen as a Cooling Medium for Electrical Machinery

AT A meeting on Friday evening, Oct. 23, of the New York Section of the American Institute of Electrical Engineers, Edgar Knowlton, Chester W. Rice and E. H. Freiburghouse presented a paper on Hydrogen as a Cooling Medium for Electrical Machinery, which was based on experiments made on a commercial machine. The authors[1] gave the important characteristics of hydrogen when compared with air as a cooling medium for large high-speed electrical machines as: Lower density; higher thermal conductivity; higher forced heat convection; practically no damage to insulation by corona; prevention of fire.

Tests in hydrogen have shown a windage loss of 10 per cent of that in air. The total losses of large-capacity alternators of 1,800 or 3,600 r.p.m. amount to approximately 2½ per cent, and the windage loss is one or more per cent of the rated capacity. By operating such a machine in hydrogen the windage loss is practically eliminated and results in about 1 per cent increase in efficiency.

Heat Conductivity

Hydrogen has approximately seven times the heat conductivity of air or as high a thermal conductivity as the ordinary insulating materials. When a machine is operated in air, any spaces in the insulation or between the insulation and slot sides appreciably increases the thermal drop from the copper to the surface from which the heat is to be removed by the air. With hydrogen in the machine the gas spaces are no longer harmful in this respect, because of the greater heat conductivity of the hydrogen. The efficiency of heat removal by high-velocity gas blowing over the surfaces is approximately 1.3 times as great in commercial hydrogen as in air. In other words, the surface film temperature drop required in the hydrogen machine to transfer one watt per square inch is 77 per cent of that required for the same machine in air.

The potential gradient at which corona starts in hydrogen is approximately 60 per cent of that at which it starts in air. Thus a machine designed to operate in air without corona might produce severe corona when operated in hydrogen at atmospheric pressure. The destructive nature of corona in air on insulation is well known and it was, therefore, feared that insulation troubles would soon develop, if a standard machine without corona shields were operated in hydrogen. To test this point some preliminary comparative endurance tests were made in hydrogen and air on two similar samples of yellow varnished cloth.

The main point of interest was the strikingly different appearance of the corona in the two gases. In air there were vicious needlelike streamers coming out from spots along the wires, while in hydrogen the appearance of corona was soft and diffuse in character, and gave the impression that hydrogen corona would be harmless compared with air corona on the same sample and at the same voltage, as the tests proved to be the case.

In steam turbine generators there have been cases of fire starting on the surfaces of insulation without any electrical failure. If ventilated with air, the fire may spread with great rapidity, and injure the winding to the extent of requiring extensive replacement. Also a slight electrical failure, involving initially one or two coils, may start an equally serious fire. With hydrogen no fire can occur and the damage due to an electrical failure will be confined to a few coils.

Fire Protection of Generators

Most of the large capacity air-cooled steam turbine generators are provided with pipes for the injection of steam or water in case of fire. The pipes are usually located near the ends of the windings, and when the steam or water is turned on, the ends of the windings are enveloped or covered by the extinguishing substance as the case may be. When there is a suspicion of a fire, the operator naturally wishes to be sure that the situation is serious before a machine is taken off the line and subjected to steam or water, and the tendency is to wait so long that damage may be done either by the fire or by the amount of steam or water that is turned into the machine. With a hydrogen filled machine no such disturbing condition can exist. The only failure to be considered is an electrical short-circuit or ground, and the well-known automatic devices now available should remove the machine from the line before any serious damage results.

A high-speed marine type alternator was selected for the tests, since it had fairly high windage losses, also because the outer shields which carried the armature were cast integral with the bearing supports, thus making a short closed-circuit system of ventilation readily obtainable.

Devices Used To Detect Explosive Mixtures

Mechanical and electrical devices were used to detect explosive mixtures, automatically eliminate them, and prevent high pressures in case explosions should occur.

A small gasometer was connected to the point of lowest pressure in the machine, thereby maintaining a constant pressure slightly above that of the atmosphere, independent of temperature changes and leakage. Although leakage occurred on account of the crude joints between sheet iron and rough castings, the desired pressure was automatically maintained and contamination by air was prevented.

A recording device developed by C. Dansizen gave an accurate continuous log of the amount of impurity in the hydrogen. This device produced a graphic record of the difference in potential between the terminals of a pure metal filament placed inside the generator and through which a constant electrical current was automatically maintained. The resistance of the filament is a function of its temperature which depends upon the rate of heat transmission from the wire to the gaseous mixture, which, in turn, depends on the amount of impurity in the gas. With this apparatus a potential drop of 11.5 volts was observed with pure hydrogen and 12.5 volts with a mixture of hydrogen and one per cent of air impurity by volume.

Another safety device consisted of a metal filament, mounted upon a suitable support, placed within the generator and maintained at a temperature of from 700 deg. to 900 deg. C. by means of an electric current. A mixture of air and hydrogen, having less than 15 per cent of air, will combine without explosion when brought in contact with the filament. The object of this device was to keep the air constantly being burned out of the hydrogen so that an explosive mixture could never be reached even though air should be continuously leaking into the machine.

Results of Heat Tests on the Machine

Results of heat tests showed that the temperature rise was about the same when the machine was filled with hydrogen and supplying 133 per cent load as when filled with air and carrying 100 per cent.

The question most frequently asked the authors by those interested in this subject is in regard to explosions.

In order to answer this question some preliminary tests were made by E. W. Kellogg. The apparatus consisted of an iron pipe 4 in. diameter by 24 in. long provided with a steam-engine indicator and spark plugs. The following maximum pressure rises were observed:

Gas Mixture by Volume	Maximum Pressure Lb. per Sq.In. Gage
20 per cent H_2 in air	53
30 per cent H_2 in air	61
50 per cent H_2 in air	54
60 per cent H_2 in air	50
65 per cent H_2 in air	50

It was impossible to ignite mixtures containing more than about 65 per cent hydrogen. On the basis of heat content an ideal mixture of hydrogen and air should produce a temperature of 4,100 deg. C. with a pressure of about 180 lb. per sq. in. gage. That such pressures are not obtained in practice is due to dissociation and the cooling effect of the enclosure. To test the effect of an explosion on insulation, small pieces of double-cotton covered wire were placed in the bomb. Examination showed the outer layer of cotton to be scorched and slightly weakened. When the pressure was relieved by a paper vent over the end of the bomb, no scorching was detected. It may be concluded from these tests that an explosion in a machine would have no detrimental effect on the insulation. To determine the feasibility of limiting the explosive pressure in a machine to moderate values by the use of suitably placed vents, a model 5 ft. by 3 ft. 7½ in. by 2 in. inside was constructed. This represented as closely as convenient the various parts of the generator. The parts were full size except that

[1] All of the General Electric Company, Schenectady, N. Y.

the model was 2 in. thick. The various spaces simulated were: Fan space; space around ends of winding; air gap; armature core and ducts; chamber encircling armature core; intake chamber; connecting passage.

Pressures were measured by a steam-engine indicator started automatically just before the ignition of the gas. In general, the thicker the diaphragm the greater was the pressure developed by the explosion. As nearly as possible equal volumes of air and hydrogen were used but, in spite of the fact that the explosive range is considerably beyond this point in both directions, there were several times that the charge failed to explode, doubtless due to incomplete mixing. Twenty-five explosions were made and the highest recorded pressure (45 lb. per sq.in.) occurred when the venting diaphragms were replaced by steel plates.

It is the opinion of the authors that there is no more reason to fear the explosion of a machine filled with hydrogen than that of other apparatus having considerable stored energy such as boilers, gas tanks, rotating elements, high-speed trains and automobiles, and various other familiar examples. Most of us fear a new condition if it has the possibility of accident, and accept as a matter of course the usual dangers of our daily lives.

Conclusions

To summarize previous statements, the advantages that may be realized in various proportions are, lower temperatures, greater capacity, lower losses, elimination of fire hazard, longer life and greater reliability.

There seems to be no great difficulty or danger in the use of hydrogen in a properly designed and operated machine.

The automatic maintenance of hydrogen pressure slightly above atmosphere will prevent the ingress of air and the possibility of the explosive mixtures.

Several devices each operating on a different principle may be used to detect a change in the mixture and give an alarm long before the mixture reaches an explosive stage.

Finally, should all of these contrivances fail to operate and a spark be applied to an explosive mixture inside the machine, the results would not be serious, since it is not difficult to vent the machine.

Protecting Electrical Equipment Against Lightning

At the Engineers Club in Philadelphia, Pa., on Saturday evening, Nov. 8, H. M. Towne, engineer, lightning-arrester engineering department, General Electric Co., gave an interesting talk on the "Design and Research in Lightning Protection," before the Philadelphia Section of the Association of Iron and Steel Electrical Engineers. Starting with the fundamental fact that a positively charged body, if brought near another body, will induce a negative charge on the latter, the speaker led up through the phenomena of lightning discharges and how they may damage equipment connected to overhead transmission and distribution lines.

The speaker said that lightning causes trouble on overhead transmission and distribution systems in two ways—by inducing a high voltage on the line, and by direct stroke. The latter is of rare occurrence, but by far the most severe and difficult to provide protection against. In fact, the severity of a direct stroke of lightning on a power system is such that about the only thing that can be done is to trust to luck and make the repairs. There is probably only one chance in one thousand of a direct stroke of lightning on a line. One of the reasons for this is that the line is insulated from the earth and the discharge is to earth and not to the line.

Low-Resistance Grounds Necessary on Arresters

By far the most common cause of lightning disturbances on power systems is due to induced voltages on the lines by thunder clouds charged with static electricity. It is against these voltages that lightning arresters give protection to electrical equipment. Mr. Towne showed by Ohm's Law that the internal resistance of a lightning arrester must be low, to keep the discharge voltage at a safe value, when the current to ground is high. It is also essential that the ground connection on the arrester be low. For example, if the internal resistance of the arrester were five ohms and that of the ground 95, conditions would be just as bad as if the internal resistance of the arrester were 95 and the ground only 5 ohms. Both give the conditions of a high-resistance arrester. Therefore it is not only necessary to have low-resistance ground, but also to check the resistance of these connections at regular intervals to see that they remain in good condition.

Another requisite of good lightning protection is to have the arrester as close as possible to the line or device being protected. In the research laboratory of the General Electric Co. at Pittsfield, Mass., experiments with a lightning generator showed that when an arrester was close to the end of a line insulated from ground with two thicknesses of empire cloth, the arrester carried off the lightning disturbance on the line without breaking down the empire cloth. When the connection between the arrester and line was made 100 ft. long, the lightning discharge would build up a potential on the line that would puncture from 12 to 15 thicknesses of the cloth.

A paper on "Lightning Arresters Protection on 13,200- and 2,400-Volt Equipment" was presented by E. D. Panzer and A. R. Wood, which discussed such features as location, installation and grounding.

Brown, Boveri Co. Turbines

The relative merits of impulse and reaction turbines forms the subject of a discussion in the October, 1925, issue of the *Brown, Boveri Review*. Cuts show their design of three-cylinder tandem reaction turbines, with simple construction for each of the three turbine castings, although the length of the machine is greatly extended. The high- and intermediate-pressure turbines have their shafts rigidly connected, with three bearings. Connection to the low-pressure turbine is through a flexible coupling, with a second flexible coupling to the generator. The steam connections to the high-pressure turbine are very flexible, to allow for free expansion of turbine and piping. The throttle and governor valves are securely anchored to the foundation. Axial thrusts are substantially eliminated by suitable rotor design, and any small residual thrust is taken by thrust bearings of the segmental type, similar to the Michell or the Kingsbury. The characteristic feature of the Brown, Boveri thrust bearing is that the segmental blocks are supported by steel balls.

Minimizing Steam Leakage

An interesting feature is the design of the bucket shrouding to minimize steam leakage. Each shroud ring is inclined at a slight angle to the path of the flowing steam, so that the steam, instead of striking the edge of the shroud, strikes its inner surface and is thus deflected in such a way as to reduce the tendency to escape through the clearance space. It is stated that undue emphasis has been placed upon the relatively small blade clearances and the blade-tip losses inseparable from reaction turbines, and that the chief reason for reaction turbine blading accidents in the early days, was the excessive length of the drum and the construction of the casing with cast-on strengthening ribs and equalizing steam channels. The casing was thus easily distorted through uneven expansion, stripping the blades. The earlier method of fixing the blades by calking with bronze wedges was also inadequate.

The Brown, Boveri turbines are made with short cylinders of simple form, free from cast projections, and the division of the turbine into three cylinders, decreasing the temperature drop per cylinder, entirely obviates distortion of the kind described. The bearings are close together and the blades are fixed firmly. It is stated that when the turbine is rapidly heated up, the rotor of disk-type turbine expands more rapidly than the casing, the area of the rotor exposed to the steam being many times greater than the internal surface of the casing. With the high-pressure cylinder of the new reaction turbine there is practically no difference in the rates of expansion of the rotor and casing, as both have almost the same surface exposed to the steam and the mass of the rotor is much greater than that of a disk-type machine. Further, the fact that the drum revolves makes little difference to the rate at which it becomes hot, whereas this is of great importance in the case of disk-type rotors. Even should the ends of the blades come in contact with the drum or cylinder, experience has shown that there is no danger, as the blade tips are sharpened so that they wear down easily.

Within one year 14 of these large turbines have been sold, representing a total power of 350,000 kilowatts.

News in the Field of Power

Increase of Fuel-Oil Consumption Indicated

Although official figures of the Bureau of Mines on the consumption of fuel oil in October are not available as yet, preliminary estimates indicate that this petroleum product is being used to a greater extent than ever before as a result of the anthracite miners' strike.

Fuel-oil consumption, which has grown steadily for the last decade, is expected to establish a new high record this year, and as a result supplies held by producers are lower than normal.

Dr. Von Miller Honored in Chicago

Dr. Oskar von Miller, founder and director of the Deutsches Museum of Munich, Germany, was tendered a luncheon on Monday, Nov. 9, at the Congress Hotel, Chicago, by representative engineers of the city. W. L. Abbott, president-elect of the A.S.M.E., acted as chairman.

The Doctor spoke regarding his tour through this country to see engineering work of interest, particularly electrical, hydraulic and railway, and note the improvements since his last visit in 1912. Originally, he had crossed the Atlantic upon the invitation of the committee forwarding the plans for the National Museum of Engineering and Industry. As director of the great institution in Munich of like character, his experience and advice is considered invaluable. He is the government administrator for the German railways, under the Dawes plan. He is a pioneer in electrical transmission, having erected the first high-voltage transmission line from Lauffen to Frankfort to supply the energy required for the industrial exposition held in the latter city in 1891. The line was 120 miles long and the voltage 25,000, as compared to 3,000 volts, the highest in use before that time.

His interest in electrical matters originated at the Paris Exposition in 1881, where he had the opportunity to inspect Edison's working exhibit of a single incandescent lamp. Doctor von Miller has been responsible for the design of a number of hydro-electric plants in Germany and has been prominent in railway work.

Water-Power Resources of Virginia To Be Surveyed

An appropriation of $75,000 as the initial outlay for a survey of the water-power resources of Virginia will be asked of the next General Assembly, according to Wilbur A. Nelson, chief of the department of geology at the University of Virginia. The survey, which has been planned by a commission appointed to study the state's resources, will cost $150,000 and will take four years to complete.

Two Muscle Shoals Reports Will Be Submitted

The majority and minority reports of the Muscle Shoals Commission are nearing completion. There still is some rumor that there are to be three reports, but it is believed that Senator Dial will be content to sign the report on which Chairman McKenzie and Commissioner Bower are agreed, so long as he is allowed to express certain additional views.

So far as is known the majority members of the Commission have not conferred with the Secretaries of War, Commerce and Agriculture in the formulation of their conclusions. Commissioners Curtis and McClellan, however, are known to have observed scrupulously that portion of their instructions.

The finishing touches are being put on the majority report by Commissioner Bower and W. G. Waldo, the Commission's technologist. It is believed that the majority report recommends a large subsidy for the operation of the nitrate plants. It is on this point principally that the Commission has split. It is thought that Commissioners Curtis and McClellan insist on the separation of fertilizer production and the generation of power. They oppose any subsidy, whether in the form of power or otherwise, for fertilizer production and are unalterably opposed to allowing the government itself to be in a fertilizer business.

Gold Coast Water Power Will Probably Be Developed

In a speech A. E. Kitson, director of the Gold Coast (Africa) Geological Survey, at Winchester House, London, stated that probably water power will play an important part in the development of the mineral resources of the Gold Coast, through the harnessing of such streams as the Volta, Black Volta and White Volta Rivers.

Census of Manufactures To Gather Power Figures

The United States Census Bureau has decided to include in its 1926 Census of Manufactures the following questions, among others, on the use of electrical energy in industry:

Privately generated energy consumed for power purposes?

Privately generated energy consumed for industrial heating purposes?

Central-station energy consumed for power purposes?

Central-station energy consumed for industrial heating purposes?

Average central-station power load for the year in kilowatts?

Average central-station industrial heating load for the year in kilowatts?

Coal and Oil Consumption by Public Utilities Increases

Public untility power plants in the United States consumed 3,423,845 net tons of coal in September, according to a report by the U. S. Geological Survey. This compares with 3,341,464 tons in August, as shown by revised figures. Fuel oil consumption by utilities in September totaled 845,528 barrels, compared with 759,622 barrels in July as shown by revised figures.

The average daily production of electricity by public-utility power plants in September was 179,500,000 kw.-hr., 3½ per cent larger than the average daily output for August.

The total output of electricity by public-utility power plants in the United States from January to September, inclusive, in 1925 was 47,570,000,000 kw.-hr., an increase of 10 per cent over the same period for 1924.

Boiler Sales Reported for Six Months

	March		April		May		June		July		August	
Number of establishments reporting	17		16		14		13		13		12	
	No.	Sq. Ft. Heating Surface	No.	Sq. Ft. Heating Surface	No.	Sq. Ft. Heating Surface	No.	Sq. Ft. Heating Surface	No.	Sq. Ft. Heating Surface	No.	Sq. Ft. Heating Surface
Water-tube	90	578,370	75	390,630	67	439,120	93	417,760	92	481,820	52	348,840
Return-tube	89	121,890	78	109,220	84	110,680	89	129,080	68	96,500	60	72,560
Locomotive	47	28,490	41	32,920	34	31,190	25	18,190	15	22,200	6	3,400
Vertical	31	8,810	28	10,150	77	37,890	46	27,620	47	26,210	16	10,630
Total	257	737,560	202	542,920	262	618,880	253	592,650	222	626,730	134	435,430

American Boiler Manufacturer's Association.

New England's Need for More Power Brought Out in Six-State Conference

Representatives of Central Stations Speak on Pools of Power — Cooper Tells of Advantages of Tide Power to New England— Isolated Plant Almost Ignored

THREE problems of major importance were considered by the Conference of the Six New England States which was held at Worcester, Mass., on Nov. 12 and 13, which was attended by several hundred interested persons.

The problem of power being of outstanding interest, its importance was emphasized by nearly every speaker.

Mr. Insull, representing the interests that have already pooled the power of Maine, New Hampshire and Vermont, also spoke in favor of the power pool, so that New England might take advantage of the diversity of demand for power. He defended the holding company, which has been attacked recently by Prof. William Z. Ripley of Harvard, and others on the grounds that it has insinuated itself between ownership and management. He declared that most of the holding companies were really investing companies and said that if it had not been for the aggregation of capital gathered together by the holding companies, the development of the electric light business would not have taken place on its present large scale.

Mr. Young Emphasizes the Value of Interconnection

Owen D. Young, chairman of the Board of Directors of the General Electric Co., spoke of the advantages of interconnected power as follows:

"One of the economic guaranties of a high wage level is to put more power back of the individual worker. We must use human beings more and more to direct and control power rather than to generate it. The wage curves of the principal countries in the world follow closely their power development curves. That is to say, wherever you find a high wage level, you also find a large supply of power back of the worker.

"It has been said by Fred R. Low, Editor of *Power*, that in 1869, the first year that power statistics were included in the census, there was available to each wage earner in the mills and factories of the United States, 0.6 hp. In the census of 1919, the figure is 3.27 hp. per worker—six times as much horsepower per worker in fifty years, and the number of workers has increased in that time from two million to nine million.

"Another eminent authority has said that the higher wages in this country are due to the 29,000,000 horsepower established in our factories, which is the equivalent of 290,000,000 workers. Or to put it more dramatically, each of our workers is in position to command the power of 33 slaves. Athens had but four for each free citizen.

"My thesis is that if our wage levels are to be advanced or even maintained in this country, we must put more and more power back of the individual worker, and we must see to it that the supply is ample and that the cost is low.

"The six states of New England represent a natural economic unit with its industry dominant and its agriculture furnishing its perishable food supply. Specifically now what can it do? My answer is: Create a New England power pool and draw from that mobilized supply, through adequate integrated transmission systems, the power you need for your industry at the most economic point of production. All your sources of power that are developed or can be developed should feed into your power pool. Obviously, to the extent which it can economically be done, you should develop as much power as possible from your falling waters, because that is your most valuable raw material and it is inexhaustible.

"You can increase your supply of water power, and incidentally, improve your navigation and prevent floods by a comprehensive development of storage reservoirs which will conserve your flood waters, equalize the flow of your rivers, and make power available in greater quantities than now exists. By turning all your water powers into a common power pool, you can get the benefit of the diversity in the flow of your rivers arising from different rainfall in Maine and in Vermont. A small local power that is today being used only a few hours of the day, mobilized with others, might be useful elsewhere in New England for the hours in which it is not used at home. So through this common reservoir of power, you can have full advantage of your diversity of supply, and you can also, through your transmission system, take full advantage of your diversity of use.

"In New England there has been some feeling also that power generated within a state should not be transmitted outside the state. Unfortunately, political divisions only rarely coincide with economic ones. The thing most important for any state is to have its powers developed. They cannot be developed unless the power can be used to the highest economic advantage. If that point be within the state, well and good, but even then it needs the diversity factor of a wider area of use. If the state has to choose between leaving its powers undeveloped or having the energy from those powers go out of the state, there can be but one economic answer, whether judged by the selfish interests of the state itself or on the higher grounds of moral obligation to the nation as a whole.

"Suppose New England were to have a comprehensive survey made of its water powers as a whole, including studies for storage reservoirs which would improve and equalize the flow of her rivers. Suppose then her Public Service Commissions should agree upon comprehensive plans by which these powers, when developed, could be made available on an integrated adequate network of transmission systems throughout New England. Suppose the New England states, through joint commissions, should unify her laws regarding the development and transmission of power. Suppose, in other words, that these six states, through co-operative action, should clear the road of the legal obstacles now preventing the maximum development and use of power, and secure in effect great enabling acts permitting and encouraging the maximum use of this great resource, and at the same time uniformly control the business of power service so as to insure maximum benefit to the public and the lowest possible rates. Suppose in this comprehensive program, there should be a great network of secondary lines which would be available for highway lighting and farm electrification—would it not be a great step forward in the economic and social progress of New England?

"I venture the statement that all that is needed is to clear away the legal obstacles, to pass uniform enabling acts, and the intelligent, highminded operators of utilities in New England will develop these resources and provide that service. I do not intend to speak of water powers only, because they will undoubtedly have to be supplemented by steam. Your water power is inadequate and intermittent. Your steam stations should be most advantageously located, composed of large and economic generating units and capable of getting the cheapest possible fuel supply and adequate amounts of condensing water. If, in addition to the falling water and the steam generating plants, you can advantageously harness the tides of your northern coasts—throw the great rise and fall of the Atlantic also in your common power reservoir, then New England, which has been at a disadvantage in her raw material supply, will at last see the new day when she provides within her boundaries her most important raw material; that is, power."

Mr. Ferguson, of the Hartford Electric Light Co. and chairman of the meeting, won the applause and approval of the agricultural delegates by saying he was aware that if the cost of extending electric power to the rural communities was made to pay for itself at the start, the price of electric current would be too high for farm use.

"Therefore, it seems logical that the cities should carry the burden of unprofitable rural extensions through the development period until the farm use can be built up to self-sustaining proportions."

Describes Great Tide-Power Project

Mr. Cooper, who told of the project to generate power from the tides of Passamaquoddy Bay, an arm of the Bay of Fundy, said that the plan at present is to develop between 500,000 and 700,000 hp. the annual production will be 3,000,000,000 kw.-hr. or 75 per cent, of the output of the public utility plants of New England in 1923.

"The cheap power to be generated by the project," said Mr. Cooper, "will decentralize New England's industries, and this will mean better living conditions for the workmen, greater unit

production, lower taxation, lessen the cost of distribution of foodstuffs and remove the cause of our problems in the large centers of population."

"New England faces the parting of the ways," said Herbert Myrick, editor of *The New England Homestead*. "We are either going ahead or we are going backward."

He urged the supplying of power to the farmer at rates lower than those paid by urban users in order to foster decentralization of industry. He called upon Lewis Taylor, of Morristown, Vt., to explain how a small farming community was able to furnish power for cooking and heating at 1 cent a kilowatt-hour and 6 cents a kilowatt-hour for lighting.

COMMUNITY DEVELOPED ITS OWN POWER

Mr. Taylor, a lanky, grizzled farmer, bent with age, but vigorous in his movements, spoke briefly on the successful power development in his community and said that the only dividends that were paid were those received by the users every time they were handed a bill calling for payment of 1 cent a kilowatt-hour for electricity in their kitchens and 6 cents for lighting. The project got into trouble once, he explained.

"We were making money so fast that some wanted to divert it to pay the expenses of the village," he said. The remark evoked an outburst of laughter.

Canada's Import and Export of Electricity

The following table, published by the Department of Trade and Commerce of Canada, shows the amount of electricity exported to the United States from Canada and imported to Canada from the United States in 1924 and 1925:

(Kilowatt-hours)

	Exports		Imports	
Month	1924	1925	1924	1925
January	113,599,000	91,300,000	222,000	228,000
February	101,936,000	79,260,000	220,000	208,000
March	118,429,000	100,160,000	234,000	228,000
April	108,822,000	109,600,000	201,000	216,000
May	113,960,000	109,524,000	198,000	225,000
June	100,498,000	109,753,000	191,000	207,000
July	104,952,000	112,737,000	198,000	211,000

New 20,000-Kw. Unit Needed in Pasadena

Recommendation that authorization be given immediately for the drawing up of plans and specifications for a new 20,000-kw. unit for the municipal electric power plant at Pasadena, Calif., has been made by B. F. DeLanty, acting general manager.

The recommendation was made in the eighteenth annual report of the Municipal Light and Power Department recently filed with the city directors by Mr. DeLanty. It was based on the fact that the maximum demand during the year was 11,061 kw. and that the present plant has a maximum capacity of 12,500 kw. and the small reserve plant a capacity of 6,222 kw. only. The 20,000-kw. unit would make necessary the purchase of four 1,000-hp. water-tube boilers. It was recommended further that the new plant be so constructed as to use 350-lb. steam pressure instead of 250-lb. pressure as used in the present plant.

Tennessee River Permits Hearing on Dec. 15

Notice has been given by Major Harold C. Fiske that a public hearing will be held at 815 Broad St., Chattanooga, Tenn., on Dec. 15, on the applications that are pending before the Federal Power Commission for preliminary permits for power and power-navigation dams on the Tennessee, Clinch and Powell Rivers. The following are the applications pending: The Tennessee Hydro-Electric Co., with proposed installation of 390,000 hp.; the Tennessee Electric Power Co., for about 177,000 hp.; the Knoxville Power & Light Co., for about 32,150 hp.; the East Tennessee Development Co., for about 592,500 horsepower.

At the recent meeting of the Southeastern Division of the N.E.L.A., Major Fiske told of the survey of the Tennessee basin now under way by government engineers. He said that the work had progressed far enough to show that existing estimates of the power possibilities are conservative The survey will take two years.

Another Plan for Grand Falls Power Project

New proposals for the development of the Grand Falls water powers near Fredericton, New Brunswick, the largest potential water power in the Maritime Provinces, are said to have been put forward by the Royal Securities Co. and the Montreal Engineering Co., according to the *St. John Globe*. The scheme, it is said, is to be the development carried out by a group of corporations including the International Paper Co., the Fraser Lumber firm and other large New Brunswick lumber companies. The plans for the work are to provide for a smaller development than that which the late Veniot government had ordered.

As the upper waters of the St. John River are international, extending for some distance in the State of Maine, the International Joint Waterways Commission had given their consent for the development planned by the former government. It is suggested that the scheme now under consideration includes using only such waters as are within Canadian territory.

English Firm to Manufacture Nobel Diesel Engine

The Mirrlees, Bickerton & Day, Ltd., Stockport, Eng., have recently taken over the rights of the Nobel engines and are now manufacturing them. This engine has four single-acting cylinders, the bore being 22 in. and the piston stroke 29½ in., working on a two-stroke cycle and developing 1,000 b.hp. at 125 r.p.m., the piston speed being only 615 ft. per minute.

The special features of the design include: Utilization of the hollow columns which are interconnected so as to provide a large scavenging air reservoir, thereby obviating the necessity for large external air reservoirs; low scavenging air pressure employed, 2 lb. per sq.in.; frictionless rotary distributor used for controlling suction and delivery of scavenge pumps; de-compression valve in cylinder cover, the function of which is to raise almost immediately the scavenging air pressure to the desired 2 lb. per sq.in.

On this engine the compressors and scavenging pumps are driven by rocking levers at the back of the engine to reduce the length to a minimum; where space permits, however, they can be direct driven from the crankshaft.

Capacity of Generators of U.S. Public-Utility Plants

The total capacity of generators in electric public-utility power plants in January, 1924, was 19,400,000 kw.; in February, 1925, the total capacity was 22,500,000 kw., an increase of over 3,000,000 kw., or about 16 per cent in the 13-month period. The following table shows the capacity of generators in public-utility power plants in the United States.

	Kilowatts
United States	22,523,502
New England	2,198,022
Middle Atlantic	5,913,175
East North Central	5,186,295
West North Central	1,778,146
South Atlantic	2,587,140
East South Central	890,105
West South Central	759,253
Mountain	828,075
Pacific	2,383,291

The Geological Survey reports that the average production of electricity by public utility power plants in Sept. was 179,500,000 kw.-hr., 3½ per cent larger than the average output for August.

A Sixth Great Lake Would Create 500,000 Hp.

An elaborate scheme for the creation of a "sixth great lake," twice the size of Lake Ontario, in northern Ontario, was placed before the associated boards of trade and chambers of commerce of Ontario at their annual banquet at Kingston, Ont., on Nov. 5.

The proposal, as outlined by C. Lorne Campbell, of Toronto, means the building of two dams across the Albany and Ogoki Rivers to turn the waters of these streams away from the James and Hudson Bays into Lake Nipegon.

This, according to Campbell, would create a lake 200 miles long by 90 miles, wide, and cause to be submerged an area of 18,000 square miles.

The cost is estimated at $200,000,000 and 20,000 men would be employed for six years. The expenditure would not fall on the shoulders of the province of Ontario, according to Campbell, except in the way of agreeing to take a certain horsepower of the vast new electrical energy developed at three centers. The capacity at Cameron Falls would be increased by 175,000 or 200,000 hp.; the power plant at Sault Ste. Marie would have its capacity increased by 40,000 or 50,000 hp.; at Niagara Falls 300,000 hp. would be added. In all an increase of 500,000 horsepower.

The scheme, international in scope, in Campbell's opinion, would overcome the Chicago diversion of water from the great lakes in twelve or fourteen years, at the end of which time the level of the lakes would be back to normal.

Trenton Channel Plant To Be Enlarged

Work on the extension to Trenton Channel plant of the Detroit Edison Co., is under way. The extension is being built for a fourth 50,000-kw. turbine. Extensions to switchhouse, coal unloading pit, coal breaker and conveyor house and coal preparation house are also being made. While present plans call for the installation of only one more turbine at this time, the turbine structure and superstructure are being extended to accommodate six machines. The boiler-room foundation is also being enlarged to twice its present size, and excavating work for this extension will be started shortly.

Obituary

William J. Wickes, president of the Wickes Boiler Co., Saginaw, Mich., and vice-president of Wickes Brothers, died suddenly on Nov. 1 of heart failure. He had been in excellent health before the fatal attack. Mr. Wickes was born in 1862. When he was sixteen years of age he entered the business of Wickes Brothers, which was owned by his father and uncle. In 1907 the Wickes Boiler Co. was organized and he was made president of that company, holding this position until his death. During the war he was president of Saginaw Shipbuilding Co., which built 40 ships for the U. S. Shipping Board. E. B. Wickes, his son, was recently elected to the vice-presidency of the Wickes Boiler Co. to take the place of the late E. C. Fisher. Mr. Wickes beside holding the positions mentioned, was president of the Consolidated Coal Co., of Saginaw, and the U. S. Graphite Co. He was vice-president and director of the Bank of Saginaw and for ten years was president of the Saginaw Plate Glass Co., which was sold in 1921 to the Fisher Body Division of the General Motors Co. Mr. Wickes is survived by his widow, three sons and three daughters.

Allen A. Tirrill, well known to the power-plant field, through his voltage regulators, the notice of whose death on Sept. 21 has just been received, was one of the most painstaking and gifted inventors of the present age. He succeeded in designing and perfecting the only two generator voltage regulators which have ever proved commercially feasible, the first of which bears his name. The voltage regulator was almost the sole thought of Mr. Tirrill for more than twenty years. During that time he designed two separate regulators of the vibrating type, but each based upon exclusive and distinctive basic ideas. Following their operation in service, Mr. Tirrill year after year made improvements and adjustments upon his original work. The first of his two regulators he sold to the General Electric Co. in 1902. Prior to that time he had installed a vast number of water-power electric plants throughout New Hampshire, including the first electric light station in this state, which was located at Stewartown. It was during this pioneer work that he saw the need of constant generator voltage. He installed his first regulators in Concord and Lakesport, N. H. in 1897, nearly five years before his patent was purchased by the G. E. Co. In 1908 the G. E. Co. sent Mr. Tirrill to Europe to demonstrate the practicability of his regulator there. Shortly after his return he resigned from the G. E. Co. to enter the employ of the Westinghouse Electric & Manufacturing Co., at East Pittsburgh, where he designed the second and latest regulator. In 1916, deciding to stop the designing of electrical apparatus and devote his time to miscellaneous inventions, he resigned his position with the company. He was retained, however, by the company in a consulting capacity. In 1914 he was awarded the John Scott Legacy Medal for his inventions, together with a diploma from the Franklin Institute of Philadelphia. Of a quiet and retiring disposition, Mr. Tirrill seldom talked before technical associations although he was a member of the A.I.E.E. for thirty-four years.

Personal Mention

H. M. Vehling is now connected with the New York office of the Federal Light & Traction Co. Mr. Vehling was formerly in Milwaukee.

Theodore Schou, chief engineer of the Ideal Electric & Manufacturing Co., Mansfield, Ohio, has returned from a four months' visit to Europe.

M. H. Harrington, a frequent contributor to *Power's* correspondence columns, has returned to Fall River after a five-month trip through Alaska and the Northwest.

Charles Steinbrecher, formerly machine-shop foreman, has been appointed assistant maintenance engineer of the Conners Creek power plant of the Detroit Edison Company.

Karl MacDonald has resigned as mechanical engineer with the Terry Steam Turbine Co., of Hartford, Conn., to accept a similar position with the Moore Steam Turbine Corp., Wellsville, N. Y.

René J. Bender, who has been working in the research department of the Combustion Engineering Corp., New York City, has been transferred to the French branch of this firm and will be located in Paris.

A. J. Houghton, Jr., formerly connected with the engineering department of the Southern California Edison Co. at Los Angeles, has severed his connection with that utility to join the Municipal Department of Water and Power, Bureau of Power and Light.

William J. Miller has resigned from the University of Arkansas, where he served as electrical and mechanical research engineer in the engineering equipment station, to become dean of engineering at the Texas Technical College, Lubbock, Tex.

Fred H. Cook has been appointed chief hydraulic engineer for the Holyoke Water Power Co., to fill the vacancy caused by the death of Albert F. Sickman, on Oct. 17. **Allan W. Ladd** assumes the position of assistant hydraulic engineer formerly held by Mr. Cook.

H. T. Herr, resident vice-president of the Westinghouse Electric & Manufacturing Co., South Philadelphia Works, and designer of steam-turbine improvements, hereafter will direct the general management of the local plant as well as the stoker works at Attica, N. Y. He will, in addition to the engineering and production work, direct the sales.

Dr. J. B. Whitehead, professor of electrical engineering and dean of the faculty of engineering of Johns Hopkins University, Baltimore, has received the triennial prize of 4,000 francs, for the year 1925, of the Foundation George Montefiore, of Liege, Belgium, for the best original work contributing to scientific advancement in the technical application of electricity. The prize is awarded for his papers on "Gaseous Ionization in Built-up Insulation."

Society Affairs

The Philadelphia Section of the A.S.M.E. will hold a session on Nov. 23 which will be devoted to power problems.

The St. Louis Section of the A.S.M.E. will hold a joint meeting with the student branch at the Washington University on Nov. 20. The new power plant will be inspected.

The Rochester Engineering Society will hear C. R. Pettis, superintendent of New York State Forests, speak on "Reforestation," at its Nov. 20 meeting, which will be held in the Carnegie Bldg. of the University of Rochester.

The Engineers' Club of the Lehigh Valley, Lehigh Sections of the A.I.E.E. and **A.S.M.E.**, will hear Samuel S. Wyer speak on "Giant Power" at a meeting on Nov. 27, which will be held at Drown Hall, Lehigh University.

The Metropolitan Sections of the A.S.M.E., A.S.C.E., A.I.E.E., A.I.M.& M.E., together with the **Engineering Section of the American Society of Safety Engineers** will hold an all-day Accident Prevention Conference on Nov. 18, at the Engineering Societies Bldg., 29 West 39th St., New York City. Dr. W. F. Durand, Robert Ridgway and M. I. Pupin will preside at the different sessions and addresses will be delivered on the various aspects of safety and the obligation of the engineering profession in assisting in the prevention of the present appalling loss of lives through preventable accidents.

The Baltimore Sections of the A.S.M.E. and A.I.E.E., together with the **Engineering Society of York, Pa.**, will hold an all-day inspection trip to the Holtwood steam and hydro stations and coal preparation plant of the Pennsylvania Water & Power Co. on Nov. 21. V. W. Alden, of the Consolidated Gas, Electric Light & Power Co., will speak on "The Holtwood Steam Station;" "Recent Experiences with Transmission System of the Pennsylvania Water & Power Co.," will be the subject of A. F. Berry and E. Hansson, of the Penn. company; and "Maintenance at the Holtwood Plant" will be the topic of T. C. Stabley.

Business Notes

The Foxboro Co., Inc., Foxboro, Mass., announces that its Southern office has been transferred from Birmingham to Room 426, Atlanta Trust Bldg., Atlanta, Ga. and that A. W. Taber, formerly connected with the Boston territory, will be in charge of the Atlanta office as Southern district manager.

The Uehling Instrument Co., 473 Getty Ave., Paterson, N. J., announces that P. J. Riccobene has recently joined the home sales office of the company; The Ernest E. Lee Co., 115 South Dearborn St., Chicago, is to represent them in Northern Illinois and Northern Indiana; The Coon De Visser Co., which has been representing the Uehling company for several years in Michigan, has moved from 1772 West Lafayette Blvd., to 2051 West Lafayette Blvd., Detroit, Mich.

The Bell & Gossett Co., 3,000 Wallace St., Chicago, Ill., announces the establishment of a general industrial instrument department which will pay particular attention to the engineering phases of pyrometer installations. C. C. McDermott, formerly with the Brown Instrument Co. and the Republic Flow Meters Co., will head this department and R. E. Soules will be associated with him. Large stocks of complete thermocouples of the various elements commonly used as well as protecting tubes will be carried.

Trade Catalogs

Ammeter, Voltmeter, Ohmmeter — The Electrical Engineering Service, 15 Park Row, New York City. A small folder describing the ammeter, voltmeter and ohmmeter in one has recently been issued by this company.

Spray, Rotor — The Hardinge Co., York, Pa. Bulletin No. 29 gives descriptive drawings and photos of the action and construction of the rotor spray, manufactured by them for gas scrubbing, air conditioning, absorption, concentration, mixing, aëration, heating, and cooling.

Flow Meters—The General Electric Co., Schenectady, N. Y. Bulletin No. GEA-10, "G.-E. Mechanically Operated Flow Meters, for Measuring Fluids and Gases," was issued in October. It contains full descriptions of the different types of meters, drawings, charts and price lists.

Tools, Small—The Greenfield Tap & Die Corp., Greenfield, Mass. Catalog No. 49, describing the products of this firm was issued in September. The catalog covers the small tool and additions to lines of taps, dies, screw plates, gages, etc., as well as changes in the price list.

Monel Metal Buyers' Guide—The International Nickel Co., 67 Wall St., New York City. "The Monel Metal and Nickel Buyers' Guide" has just been issued by this company. The list is arranged alphabetically under the object and again under the firm name of the distributor. A copy may be obtained on request.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28-Jan. 2.

American Institute of Chemical Engineers—Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Sinton Hotel, Cincinnati, Ohio, Dec. 2-5.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 4.

American Society of Refrigerating Engineers. William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 2.

American Society of Safety Engineers. G. S. Wood, 29 West 39th St., New York City. Meeting at New York City, Nov. 18.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Hotel Chelsea, Atlantic City, Nov. 23-25.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30.

National Association of Practical Refrigerating Engineers. Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Marine Engineers Beneficial Association. George A. Grubb, 313 Machinists Bldg., Washington, D. C. Convention at Washington, D. C., Jan. 18.

National Research Council, Engineering Division. William Sparagen, 29 West 39th St., New York City. Fifth annual meeting at Washington, D. C., Dec. 3-4.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Pipe Threading Devices—The Toledo Pipe Threading Machine Co., 1425 Summit St., Toledo, Ohio. Catalog "H" describes, with tables of dimensions and prices, these devices for cutting, holding and threading pipes and also the "Toledo" power drives.

Recorder — The Bristol Co., Waterbury, Conn. "Bristol's Mechanical Motion and Electrical Operation Recorder" is described in Catalog No. 1600, recently issued by this company. Price list, charts, drawings and photos of installations are included.

Motors — The Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio, "Ball and Roller Bearing Reliance Motors" is the title of the new catalog recently issued by this company. Clear illustrations of the motor, photos of installations and tables of sizes give value to this Bulletin No. 4000.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Nov. 9 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	2.12
Clearfield	Boston	1.85@ 2.35
Somerset	Boston	1.95@ 2.50
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.85
Pittsburgh	Pittsburgh	2.15@ 2.25
Pittsburgh gas slack	Pittsburgh	1.25@ 1.35
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.20@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.75
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.60

FUEL OIL

New York—Nov. 12, light oil, tank-car lots; 28@34 deg. Baumé, 4¾c. per gal., 36@40 deg. 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Nov. 3, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2.00 per bbl.; 30@32 deg., $2.05 per bbl.; 32@36 deg., gas oil, 5¼c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Nov. 3, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5¾c. per gal.

Dallas—Oct. 24, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Nov. 5, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.70@$1.76; 13@19 deg., $1.60@$1.66 per bbl.

Boston—Nov. 9, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5.65c per gal.

Cincinnati—Nov. 10, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¼c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6½c. per gal.

Chicago—Nov. 10, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40.

New Plant Construction

Calif., Long Beach — Southern California Edison Co., American Ave., awarded contract for addition to steam plant No. 2 to consist of the installation of a 50,000 kw. turbo-generator and seven 1,500 hp. boilers, extension of condensing water tunnels and an addition to fuel oil storage facilities; four-bay extension to the switch house, two additional outgoing feeders and an additional 60,000 kva. transformer bank to Stone & Webster, 147 Milk St., Boston, Mass.

Calif., Los Angeles—Hotel Holding Co., J. M. Schenck and C. E. Toberman, associated, awarded contract for the construction of a 12 story hotel at Orange Dr. and Hollywood Blvd. to Trewitt & Shields, 801 Edwards & Wildey Bldg. Estimated cost $3,500,000. Steam heating system and elevators will be installed.

Calif., San Francisco — Weeks & Day, California Insurance Bldg., Archts., is receiving bids for the construction of a 15 story hotel on Mason St. for California-Mason Realty Co., c/o architects. Estimated cost $4,500,000.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded contract for the construction of a frequency change house at 2200-2262 Fisk St., to J. W. Snyder Co., 307 North Michigan Ave., also addition to electric switch house to G. F. Meyne, 127 North Dearborn St. Estimated cost $75,000 and $155,000 respectively.

Ill., Chicago—Cook County Comrs., Room 519, County Bldg., has had plans prepared for the construction of a group of hospital buildings at Harrison, Wood, Polk and Lincoln Sts. Estimated cost $2,500,000. E. E. Hall of Hall, Lawrence, Rippel & Radcliffe, 123 West Madison St., is county architect.

Ill., Chicago—Guske & Foster, 750 North Michigan Ave., Archts., is receiving bids for the construction of a 10 story apartment at DeWitt St. and Delaware Place for A. O'Rourke, 111 West Washington St. Estimated cost $750,000.

Ill., Chicago—J. L. Guyon, 124 North Crawford Ave., is having plans prepared for the construction of a 10 story office and stores building at Crawford Ave. and Washington Blvd. Estimated cost $1,000,000. J. J. Jenson, 1105 Lawrence Ave., is architect.

Ill., Chicago—C. Morgan, c/o J. A. Nyden, 190 North State St., Archt., will receive bids about Dec. 1 for the construction of a 10 story hotel at Hyde Park Blvd. and Dorchester Ave. Estimated cost $1,250,000.

Ill., Chicago—Union News Co., 507 West Monroe St., is having plans prepared for the construction of a 12 story office and storage building at 717 West Jackson Blvd. Estimated cost $1,000,000. Fellheimer & Wagner, 155 East 42nd St., New York, N. Y., are architects.

Ill., Staunton—City will readvertise for bids for the construction of waterworks system including two 500,000 gal. filter units, steam heating plant, 200,000 gal. reservoir, dam, two 700, two 500 and one 1,000 g.p.m. motor driven pumps, etc. W. A. Fuller, 1917 Railway Exchange, St. Louis, Mo., is engineer. Former bids rejected.

Ind., Michigan City — Calumet Gas & Electric Co., c/o Midland Utilities Co., 122 South Michigan Ave., Chicago, Ill., is having plans prepared for the construction of an electric generating station 60,000 kw. or approximately 80,000 hp. initial capacity; two turbines 30,000 kw. or 40,000 hp. have been ordered. Estimated cost of first unit $6,500,000. Marshall & Fox, 431 North Michigan Ave., Chicago, Ill., are architects. Sargent & Lundy, 72 West Adams St., Chicago, Ill., are engineers.

Ind., Terre Haute — W. E. Russ, Indianapolis, Archt. and Engr., is receiving bids for the construction of an 11 story hotel at 7th and Wabash Sts., here, for heirs of Crawford Fairbanks. Estimated cost $900,000.

Kan., Wichita—F. W. Stevens, et al., 620 West Douglas Ave., will build a 10 story hotel. Work will be done by day labor under supervision of The Industrial Builders, 620 West Douglas Ave., Archts. Schuler & Co. are associate architects.

Md., Baltimore—Standard Electric Machinery Co., 7 and 9 East Hill St., is in the market for a 3 or 5 kw. Boston vertical battery charging motor generator set with 3 ph., 60 cycle, 220 v. driving motor and non-automatic or automatic panel (used.)

Mass., East Boston (Boston P. O.)—Dept. of Public Works, J. A. Rouke, Comr., Boston, plans the reconstruction of pumping station and masonry conduits for sewage system on Maverick St. here. Estimated cost $700,000.

Mich., Detroit—A. Kahn, 1000 Marquette Bldg., Archt., will receive bids until Nov. 24 for the construction of a 10 and 14 story office building including steam heating boilers and equipment on Woodward Ave., for The Maccabees, A. W. Frye, Congress and Shelby Sts. Estimated cost $2,500,000.

Minn., Mankato—F. W. Bates, Clk., will receive bids until Nov. 23 for pumping equipment: furnishing and installing a 2,000 g.p.m. high service unit and a 1,600 g.p.m. low service unit, 750 g.p.m. deep well impeller or turbine pump, and removing 3 pump units from pump station. P. F. Comstock, is city engineer.

Minn., Minneapolis — Wesley Methodist Church, c/o F. L. Roberts, 4642 Garfield Ave., plans the construction of a 9 story hotel and community center on Grant St. and Stevens Ave. Estimated cost $1,000,000. Colburn & Forsell, 210 South 9th St., are architects.

Miss., Vicksburg—Lamb-Gary Mfg. Co., P. O. Box 675, will build a woodworking plant including a power house, dry kiln, etc., by day labor. Estimated cost $125,000.

Mo., Harviell—Arkansas-Missouri Cotton Co., wants prices and data on cotton gin equipment and force pumps to be driven from line shaft about 250 to 350 g.p.h.

Mo., Higbee—Moniteau Coal Co., A. E. Humphrey, Secy., plans the installation of boilers, pumps, etc.

Mo., Pierce City—City will receive bids until Nov. 30 for the installation of deep wells, bids for a 50,000 gal. reservoir and air lift pump will be taken later.

Mo., St. Louis—Saum Bros., 713A Chestnut St., will build a 9 story apartment at Grand and Castleman Aves., by day labor. Estimated cost $1,000,000.

Mo., Sedalia—City awarded contract for the construction of a pump and boiler room to W. W. Hocker. $30,000.

N. J., Camden—Syndicate, c/o J. O. Wilson, 4th and Market Sts., plans the construction of a 12 story office building on Cooper St. Estimated cost $1,000,000. L. B. Rothchild, 215 South Broad St., Philadelphia, Pa., is architect.

N. Y., New York—Babies Hospital, 135 East 55th St., is having preliminary plans prepared for the construction of a hospital at Broadway and 168th St. Estimated cost $1,000,000. H. C. Pelton, 15 West 42nd St., is architect and engineer.

N. Y., New York — Hess & Kahn, 345 Madison Ave., Archts. and Engrs., will build a 2 story hotel at 2-10 East 86th St. Estimated cost $3,000,000. Work will be done by separate contracts.

N. C., Charlotte—Southern Power Co., 432 South Church St., plans the construction of a 100,000 hp. steam electric plant. The energy will be supplied by two 35,000 kw. steam turbine generators, 43,750 kva., 80 per cent power factor, 3 ph., 60 cycle, 13,200 v.

O., Cleveland—The Taylor Chair Co., Bedford, is in the market for a 250 to 325 hp. Sterling boiler for plant here (used.)

O., Cleveland—A. N. Weltman, 3320 Ormond Road, is receiving bids for the construction of a 6 story hotel at 1588 Ansel Road. Estimated cost $600,000. H. B. Beidler, Ulmer Bldg., is architect.

O., Summitville—F. H. Johnson and H. P. Lynn, will soon receive bids for the construction of a brick plant including power plant to replace fire loss. Estimated cost $50,000.

Okla., Marlow — City, L. W. Pritchett, Supt., is in the market for two new deep well pumps and motors 100 g.p.m. capacity against a 200 ft. head.

Okla., Purcell — City is having preliminary plans prepared for the construction of a sewage disposal plant including Imhoff tanks, motor driven pumps, etc. Estimated cost $45,000. Engineer not announced.

Okla., Wagoner—C. Page, Sand Springs, has been granted permit to construct a hydro electric project including a power plant and 50 x 1,200 ft. dam across the Illinois river in Adair county here. Estimated cost $250,000. C. Tingley, Sand Springs, is engineer.

Pa., Beaver Falls—G. Davidson, First National Bank Bldg., plans the construction of a 6 story hotel, bank and office building at 7th Ave. and 12th St. Estimated cost $700,000. E. E. Bailey Co., Oil City, is architect.

Pa., Philadelphia — H. Kline, Bulletin Bldg., will soon award contract for the construction of a 1 story apartment at 1106 Walnut St. Estimated cost $200,000.

Pa., Philadelphia—Parkway Apartment Corp., c/o F. Gresiler, 1035 Walnut St., Archt., plans the construction of a 14 story apartment at 33rd and Columbia Sts. Estimated cost $1,750,000.

Pa., Philadelphia—United Gas Improvement Co., Broad and Arch Sts., will soon award contract for the construction of a 14 story office building at 1409-1415 Arch St. Estimated cost $1,000,000 Perry, Shaw & Hepburn, 177 State St., Boston, are architects.

R. I., Westerly—City is receiving bids for the construction of a pumping station. Estimated cost $25,000. W. T. Arnold, 342 West Main St., is engineer.

S. C., Lexington—W. S. Caughman, Chn. of Bd. of Public Works, will receive bids until Nov. 24 for the construction of a water purification plant including reservoir, two 500 g.p.m. fire pumps, etc. Carolina Engineering Co., Charlotte, N. C., is engineer.

Tenn., Knoxville — City, L. Brownlow, Mgr., plans to expend $60,000 for the construction of a refrigeration plant in municipal market house.

Tenn., Nashville—City plans an election Dec. 17 to vote $100,000 bonds for the construction of a new boiler plant, power and heating plant including boilers and heating equipment for city hospital. H. E. Howse, mayor.

Tex., Huntsville—Eastham Bros., plans the construction of a mattress factory to replace fire loss. Estimated cost $75,000. Private plans. Electric motors, etc., will be required.

Tex., Jacksonville—City is receiving bids for the construction of a sewage treatment and disposal plant, pumping plant, etc. Estimated cost $65,000. G. L. Fugate, City Hall, is engineer.

Tex., Kingsville — Kingsville Produce & Milling Co. plans the construction of a 20 ton refrigeration and cold storage plant. Estimated cost $50,000. Company engineers in charge.

Tex., Palacios—Texas National Guard, 36th Div., c/o E. Vandevanter, plans the construction of a refrigeration plant. Estimated cost $30,000.

Tex., San Antonio—Smith Bros. Construction Co., American Express Bldg., is having preliminary plans prepared for the construction of an 8 to 10 story hotel at St. Marys and Villita Sts. here. Estimated cost $1,000,000. A. B. and R. M. Ayres, Bedell Bldg., San Antonio, are architects.

Tex., San Marcos—Texas Public Utilities Co. has purchased electric and ice plants in Martindale, Maxwell, Reedville and Staples from private owners and plans enlargements and improvements to same including additional engines, dynamos, etc., for light plants. Estimated cost $200,000. Private plans.

Tex., San Saba—Texas Power & Light Co., has purchased a light and ice plant and plans improvements including additional tonnage to ice plant, also engine, dynamos, etc., will be installed in light plant. Private plans.

Wis., Antigo—Vulcan Last Co., plans the construction of a woodworking plant including four 600 hp. boilers, etc. Architect not selected.

Wis., Milwaukee — Milwaukee Electric Railway & Light Co., Public Service Bldg., awarded contract for the construction of a carbonization building on Lake Road to Milwaukee Bridge Co., 1400 34th St.

Wis., Milwaukee — Milwaukee Hospital, 22nd and Cedar Sts., is having plans prepared for the construction of a laundry and power house for hospital. Estimated cost $60,000. R. Cramer, 1105 Vliet St., is engineer. Equipment has been arranged for